PEACE/WILLISTON
FISH & WILDLIFE
COMPENSATION
PROGRAM

Upland Furbearer Problem Analysis

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D. Q. Becker
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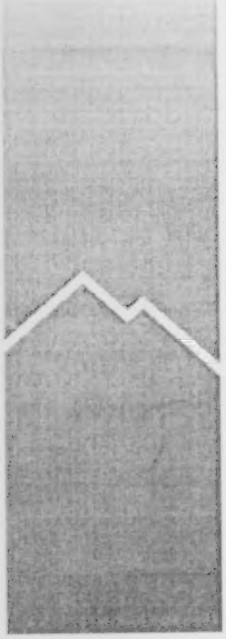

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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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EXECUTIVE SUMMARY

The Williston Wildlife Compensation Program (WWCP) is a joint venture between B.C. Environment and B.C. Hydro to enhance and protect wildlife resources affected by the Williston Lake reservoir. One of the wildlife resources affected was upland furbearers. Upland furbearers include marten *(Manes americana)*, lynx *(Lynx, canadensis)*, fisher *(Manes pennanti)*, wolverine (*Gulo gulo*), wolf (*Canis lupus*), coyote (*Canis latrans*), weasel *(Mustela frenata)*, and fox *(Vulpes vulpes)*.

The preservation, maintenance or enhancement of upland furbearers is directly related to the condition and extent of furbearer habitat. Detailed information on habitat requirements and enhancement techniques for upland furbearers was compiled to identify the priorities of research, enhancement, and integrated management. Additionally, furbearer research and enhancement opportunities were ranked by species and habitat (e.g. Biogeoclimatic subzone).

Information for the problem analysis was obtained through various sources: literature, local trappers, resource managers and furbearer experts. Available literature on habitat use, food habits and habitat selection for the eight upland furbearers was reviewed. Additionally, literature on related topics (i.e. impacts of herbicides on furbearers) and management plans for specific furbearers in British Columbia were reviewed.

Furbearer research and enhancement falls generally under two categories. The first category involves basic knowledge of species' ecology and behaviour while the second category deals with large-scale habitat changes impacting furbearer habitat.

In the first category, the quality and quantity of information dealing with habitat requirements and selection and the specific habitat characteristics important for furbearer survival are considered inadequate for most furbearers. In the second category, large-scale habitat changes primarily involve intensive forest management and associated practices. Harvesting (clear cutting) and herbicide use have been identified as the most detrimental to furbearer habitat and furbearer prey species.

The three major biogeoclimatic zones in the Williston Lake watershed are the SBS, ESSF, and BWSB. The greatest diversity and abundance of furbearers occur in these zones and any research or enhancement should be conducted in these areas.

Marten was considered the most economically important species trapped in Williston Lake watershed. Past populations of coyote, lynx, wolverine, and wolf have supported both trapping and hunting pressure in the area but marten, lynx, and beaver account for 90% of trapping revenue.

Of the eight upland furbearers in the Williston Lake watershed, four species (marten, wolverine, lynx and fisher) were considered important for either research and/or

enhancement. Although wolf, coyote, weasel and fox form integral parts of the overall ecosystem of the Williston Lake watershed, research or enhancement is not considered a priority at this time. Trappers and resource managers considered marten to have the highest priority for research and enhancement followed by wolverine, lynx, and fisher.

Each research opportunity was ranked, based on the amount of information currently available. In order of priority, habitat related research was required for wolverine, fisher, lynx, and marten. Marten has the most opportunity for enhancement since the greatest amount of information is known on habitat requirements. Wolverine had the most opportunity for research since so little is currently known.

Much of the research emphasis is on identification of critical habitat needs and inventory of populations. Additionally, emphasis is placed on how forestry practices can impact not only the furbearers but their prey species. More information is required to determine how to maintain or enhance the development of critical habitat components in second-growth forests to ensure species survival and enhance furbearer populations in the Williston Lake watershed.

Enhancement opportunities describe possible methods to improve areas for upland furbearer habitat and many enhancement techniques will come as a result of research. However, at this point, enhancement options are somewhat limited.

Most of the enhancement opportunities can be described as manipulating homogenous forest cover types (usually early-to-mature seral stages of second-growth coniferous or mixed coniferous-deciduous forests). These areas require treatments to create habitat mosaics typical of several seral stages with such features as snags and coarse woody debris.

Various enhancement methods include:

1) re-creating the effects of fires by creating habitat mosaics of various seral stages,
2) breaking up the 'uniformity' of mid-to-late seral stage second-growth stands (especially lodgepole pine) by creating openings that will provide early successional stage habitats,
3) in areas of dense second growth and little coarse woody debris (CWD), create small openings and snags with piles of debris left behind for CWD, and
4) re-create specific old-growth characteristics in second growth stands (i.e. lop off the tops of green trees for eventual snag creation).

Any enhancement or research programs will require some method of evaluating 'success' (i.e. is the objective of the program met?). Species numbers (populations) or abundance (numbers of species) are possible indicators of a program's success.

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1.0 Introduction

Objectives for the Williston Wildlife Program concerning furbearers include:

1) protecting furbearer habitat through integrated resource planning and projects,
2) ensure that trappers have enough information needed to allow successful management, and
3) ensure that forestry personnel have information necessary to understand the inter-relationship of furbearer habitat requirements with forestry practices (Davidson and Dawson 1990).

To meet these objectives, compilation of detailed information on habitat requirements and enhancement techniques for upland furbearers in the form of a problem analysis was required.

The problem analysis provides background information necessary for the development of a sound and comprehensive upland furbearer proposal. Priorities of research, enhancement, and integrated management for upland furbearers in the Williston watershed were identified. Concerns and information needs of local trappers, citizens, wildlife and forest resource managers were documented and a review of existing literature was completed. Additionally, furbearer research and enhancement opportunities were ranked by species and habitat (eg. Biogeoclimatic subzone). This type of information will help to ensure effective, integrated resource management for furbearers.

2.0 Study Approach

2.1 Location of Study Area

The Williston Lake watershed is located between 54 degrees and 58 degrees north latitude and along 121 degrees west longitude in north central British Columbia. The management area for the Williston Lake watershed is approximately 275 km in width and 525 km in length (70,860 km^2 in area) and comprises 12 Management Units of the Omineca-Peace Sub-region. There are 102 traplines listed for the area and 87 registered trappers. (For a more complete discussion of the location, physiography, and climate of the area refer to the Williston Wildlife Compensation Program Management Plan by Davidson and Dawson 1990.)

2.2 Study Area Description and General Furbearer Use

Five biogeoclimatic zones occur in the Williston Lake watershed including Alpine Tundra (AT), Engelmann Spruce-Subalpine Fir (ESSF), Boreal White and Black Spruce (BWBS), Sub-Boreal Spruce (SBS) and Spruce-Willow-Birch (SWB).

The Alpine Tundra biogeoclimatic zone occurs mainly at elevations above 1700m in the Williston Lake drainage, but may occur at elevations as low as 1500m in the Hart Foothills of the Peace Arm (Davidson and Dawson 1990). Climate and rugged topography are the overwhelming factors influencing the low wildlife species diversity and density in this zone (Meidinger and Pojar 1991).

The Engelmann Spruce-Subalpine Fir(ESSF) zone occurs at elevations between 1000m and 1700m and covers more than half of the mountainous country of the Williston basin (Davidson and Dawson 1990). The ESSF typically occurs above the Sub-Boreal Spruce zones and includes continuous forest at lower and middle elevations and subalpine parkland at upper elevations. Engelmann spruce *(Picea engelmannii)* and subalpine fir *(Abies lasiocarpd)* are the dominant climax species and lodgepole pine *(Pinus contorta)* is a widespread seral species after fires in the drier regions of the zone (Meidinger and Pojar 1991). The factors that influence the wildlife species that occur in the ESSF include climate (wet, cool summers and long cold snowy winters) and steep topography. The most common habitat, coniferous forests, are important for furbearers such as marten while young seral stage forests provide habitat for snowshoe hares *(Lepus americanus)* and lynx (Meidinger and Pojar 1991).

The Boreal White and Black Spruce (BWBS) zone occurs at the upper ends of the Peace and Finlay Arms between lake level (670m) and 1150m elevation (Davidson and Dawson, 1990). White spruce *(Picea glauca)*, trembling aspen *(Populus tremuloides)*, lodgepole pine, black spruce *(Picea mariana)*, tamarack (*Lara laricina)*, balsam poplar *(Populus balsamifera ssp. balsamifera)*, subalpine fir, and paper birch *(Betula papyrifera)* are the major tree species in the forested sections of this zone (Meidinger and Pojar 1991). Open lodgepole pine and lichen forests occur on the driest sites while lodgepole pine and trembling aspen are common as young seral stage stages on slightly moister sites. Black spruce and tamarack bogs develop on imperfectly drained sites and white spruce and balsam poplar forests are common on drained floodplains. Mixed forests of trembling aspen, lodgepole pine, and white spruce are the most characteristic and widespread upland habitat in the BWBS (Meidinger and Pojar 1991). Paper birch is often a young seral stage on moister sites (Davidson and Dawson, 1990). Despite a harsh climate, this zone is surprisingly high in wildlife abundance and diversity with many upland furbearers species occurring in this zone.

The SBS zone occupies most of the lowlands adjacent to the Finlay and Parsnip Arms of the reservoir up to approximately 1100m elevation (Davidson and Dawson, 1990). Upland coniferous forests dominate the sub-boreal landscape with hybrid white spruce and subalpine fir as the dominant climax tree species (Meidinger and Pojar 1991). Lodgepole pine and trembling aspen are seral species and lodgepole pine is common in mature forests in drier parts of the zone. Paper birch is another pioneer species occurring most often on moist rich sites. Black spruce also occurs occasionally in climax upland forest (Meidinger and Pojar 1991). Important ecological factors for wildlife in this zone are severe winters, dominance of dense spruce-subalpine fir and lodgepole pine forests, and abundant wetlands (Meidinger and Pojar 1991). Old growth coniferous forests provide abundant habitat and prey for several furbearers while other species (lynx, snowshoe hare) survive in the younger seral stages.

The Spruce-Willow-Birch (SWB) zone occurs only in the northern part of the Williston basin where it occupies the zone above the BWBS zone between 900-1700m elevation (Davidson and Dawson 1990). Lower elevations of this zone are generally forested by white spruce and subalpine fir with variable amounts of pine and aspen in the valley bottoms and on lower slopes. Higher on the slopes, subalpine fir dominates and black spruce, lodgepole pine and trembling aspen are relatively minor species, although all can be locally abundant (Meidinger and Pojar 1991). Extensive seral stands of lodgepole pine are uncommon and upper elevations of the SWB are essentially composed of a scrub/parkland subzone dominated by several species of deciduous shrubs dependent on the soil nutrient regime. The SWB has the harshest climate of all the forested zones in British Columbia, second only to the non-forested Alpine Tundra, causing many species to migrate out of this zone before winter (Meidinger and Pojar 1991). Some furbearers (marten, wolverine, wolves) are found in the coniferous forest in this zone while lynx and snowshoe hare are found in shrubby valley bottoms.

2.3 Method of Study

Information for the problem analysis was obtained from various sources: literature, local trappers, resource managers and furbearer experts. Available literature on habitat use, food habits and habitat selection for the eight upland furbearers was reviewed. Additionally, literature on related topics (i.e. impacts of herbicides on furbearers) and management plans for specific furbearers in British Columbia were reviewed.

Local trappers were contacted by means of a questionnaire with a covering letter (Appendix 9.1.1) explaining why the questions were being asked. The president of the local trappers' association helped develop the questionnaire and provided additional information. A meeting was held with the local trappers to further discuss their concerns.

Both wildlife and forestry resource managers were contacted and interviewed (in person or by telephone) and asked for input using similar questions as those on the questionnaires.

Furbearer experts were also asked for supplemental literature, contacts, and other sources of information.

3.0 Ministry of Environment, Lands and Parks Objectives and Policies Regarding Furbearers

The Provincial management strategies for furbearers is to promote a humane, biologically sound harvest with a minimum of regulatory control (Child and King 1988). The registered trapline system permits the development of a management system that places a high measure of responsibility on the trapper (B.C. Wildlife Branch 1991).

The Wildlife Branch takes the view that trapping is an ecologically sound activity that is governed by wildlife management principles (B.C. Wildlife Branch 1991). Trapping is the commercial use of wildlife, providing economic opportunities in rural and remote areas of the province that otherwise may not exist and trapping is a priority use within the Omineca subregion (excepting bear (Ursus spp.) and wolf) (Child and King 1988). Marten is, by far, the most important species trapped in the Omineca and is the "bread & butter species" for trappers (Glen Watts pers. comm.) Past populations of coyote, lynx, wolverine, and wolf have supported both trapping and hunting pressure in the Omineca subregion but marten, lynx and beaver (Castor canadensis) account for nearly 90% of trapping revenue (Child and King 1988).

Management guidelines have been developed for some furbearer species including lynx, wolverine, marten, and fisher. Larger, more complete documents on management strategy have been published for lynx, wolverine, and fisher. Management of furbearers in British Columbia is based on three elements including management (populations and their habitats), research, and education (Banci 1990).

Management Strategies have been identified for three classes of furbearers:

Class 1 species are those species present on individual traplines in manageable numbers. Class 1 upland furbearer species in the Williston Lake watershed include marten, fox, and weasel. Trappers are provided with the best information available to develop harvest strategies. Seasons are as liberal as possible, based on pelt primeness, allowing trappers maximum flexibility for the development of their harvest regimes (Child and King 1988). The Wildlife Branch monitors the species that are known to be vulnerable to over-harvesting, such as marten (B.C. Wildlife Branch 1991).

Class 2 species are those species that move between and among traplines, are vulnerable to over-harvesting, and are generally not present in manageable numbers within a single registered trapline (Banci 1990). In the Williston area this includes lynx, wolverine, and fisher. The strategy for these species may include restrictive seasons, quotas, or rotating harvests. The details of each strategy is worked out in consultation with local trappers' associations, regional staff, and provincial fur management biologist (Child and King 1988).

Class 3 species are those species not present on traplines in manageable numbers and do not appear to be vulnerable to over-harvest. Williston Class 3 species include wolf and coyote. These species move between and among traplines, but are generally not vulnerable to over-trapping (Banci 1990). Historically, trapping has not been an important factor in regulating the number of wolves and coyotes. However, both species may limit or reduce numbers of other wildlife species (B.C. Wildlife Branch 1991). The Wildlife Branch focuses on training trappers on how to trap these animals and encourages trapping in conflict areas (B.C. Wildlife Branch 1991).

Although it is important to manage furbearers for the trapping industry, furbearers are also an important wildlife resource in terms of biodiversity. One goal of the Wildlife Branch is "to maintain and enhance wildlife and their habitats, and thus ensure an abundant, diverse, and self-sustaining wildlife resource throughout British Columbia".

4.0 Summary of Literature Review on Research and Enhancement for Upland Furbearers

4.1 Introduction

Literature on upland furbearer research and enhancement is based either a specific furbearer or furbearers as a single group. Literature on upland furbearers is condensed and summarized in the following section. Species habitat requirements, research needs, and enhancement opportunities are identified. (More detailed literature reviews are found in Appendices 9.1 and 9.2.)

4.2 General Literature on Furbearer Research and Enhancement

In general furbearer literature, many topics are targeted for research but very few are specifically directed at enhancement. Many enhancement techniques will come as a result of research. For example, monitoring the effects of alternative site preparation treatments may eventually lead to specific methodology for the enhancement of furbearer habitat.

Furbearer research and enhancement falls generally under two categories. The first category involves basic knowledge of species' ecology and behaviour while the second deals with large-scale habitat changes.

In the first category, the quality and quantity of information dealing with habitat requirements and selection and the specific habitat characteristics important for furbearer survival are considered inadequate for most furbearers. Additionally, creating these specific habitat characteristics in intensively managed second-growth forest stands is also an important part of research. Population dynamics (inventory data, methods of collection of inventory and age specific population data) are also considered priorities for research.

Large-scale habitat changes primarily involve intensive forest management and associated practices. Harvesting (clear-cutting), herbicide use, brushing and weeding, and site preparation practices have all been identified as detrimental to furbearer habitat. Herbicides have especially been targeted for research due to not only their effects on furbearer habitat but on furbearer prey species (small mammals such as mice *(Peromyscus spp.)* and snowshoe hares). Various forest vegetation management procedures affecting furbearer habitat such as prescribed burning, mechanical treatments, timing of reforestation, use of appropriate planting stock, manual brushing and weeding and biological methods have all been identified as impacting furbearer habitat to some degree. Clear-cut sizes and access to previously remote areas through developing logging roads lead to additional problems for furbearer habitat utilization. Alternative harvesting practices are suggested for research as well as additional research into innovative forestry practices.

Many of the relationships between furbearers and the habitat include other species. For example, it has been well documented that lynx populations closely follow snowshoe hare population fluctuations. When hare population numbers peak, so do lynx numbers and when hare populations "crash", so do lynx populations. These types of considerations need to be taken into account in developing research objectives.

Other tools for research and development are currently in various stages of development. Habitat Suitability Index (HSI) models are a means of quantifying habitat quality and are used to predict and assess the impacts of habitat changes. The major objective is to identify habitat variables and suitability indices that are applicable over a range of successional stages but are based on a sound understanding of species ecology.

Under enhancement, topics that can be identified from research objectives include:

1) re-creating the effects of fires by creating habitat mosaics of various seral stages,
2) breaking up the 'uniformity' of mid-to-late seral stage second-growth stands (especially lodgepole pine) by creating openings that will provide early successional stage habitats,
3) in areas of dense second growth and little coarse woody debris (CWD), create small openings and snags with piles of debris left behind for CWD, and
4) re-create specific old-growth characteristics in second growth stands (i.e. lop off the tops of green trees for eventual snag creation).

4.3 Marten

In all the literature reviewed for marten, several points are fairly consistent. More literature was obtained on marten than any other upland furbearer and very little (if any) research is required on marten ecology.

Numerous studies document that marten inhabit late successional forest communities and are most abundant in association with mature coniferous species.

Nearly every study concludes that harvesting (clear-cutting) is detrimental to marten populations. In Ontario, marten are 2 to 3 times more abundant in undisturbed forests than clear-cut areas and densities in clear-cut areas in Maine were one-third of those in partially cut and undisturbed forests. These clear-cut areas were seldom used during winter, likely the result of limited access to subnivean areas thereby reducing prey availability. Marten will use clear-cuts in summer (especially near edges) if there is sufficient brush for cover.

Researchers suggest that 23 years after timber harvesting is insufficient time for clear-cuts to develop into suitable marten habitat. Other studies cite between 15 and 40 years for clear-cuts to recover as suitable habitat and is dependent on ecological site conditions and on silvicultural treatments applied. Overhead cover, small mammal availability and abundance, and resting and denning sites are critical factors for marten and these appear to be lacking in the regenerating clear-cuts. Residual stands and areas of undisturbed forest an provide these important habitat components and enable at least a remnant marten population to survive despite clear-cutting. If large scale clear-cuts continue to be the predominate method of forest harvesting (continuous cutting year-after-year), available habitat/populations will continue to decline. More intensive study of marten use of clear-cuts is required to document the stage of regeneration that will provide adequate habitat for marten.

Coarse woody debris is very important. Access and use to subnivean sites during winter is tied to the occurrence and abundance of CWD (snags, downed logs, large root masses). CWD forms subnivean rest sites and subnivean foraging during winter has been documented by several studies. The amount of CWD that should be left during logging operations and whether piles or rows of debris remain are more critical for marten utilization and should be research topics. Creating CWD in second-growth stands is an enhancement focus (i.e. in areas of dense second growth and little CWD, create small openings and snags with piles of debris left behind for CWD).

Other suggestions include research into different harvesting systems to maintain marten habitat values (i.e. partial or selective cutting). Studies have suggested that leaving 40-50% of the canopy and leaving at least 40% of the trees did not alter conditions enough to influence the preferred small mammal foods of marten. Although, some researchers have made specific suggestions regarding timber volume and canopy closure to be left for marten habitat requirements, more research could be focused in this direction.

Many silvicultural practices could be utilized to improve stand regeneration including juvenile spacing at correct times for improved conifer growth. If site conditions permit, spruce and fir should be planted in clear-cuts in marten habitat. When snow is too deep, small trees are more commonly used to get to subnivean sites (spruce and fir have large lower growing branches in contrast to larger trees and lodgepole pine).

Research alternatives to brushing and weeding stands (either manual or with herbicides) is important since marten will use regenerating stands more often if cover (brush) is available. For example, planting at correct times (rather than leaving a clear-cut unplanted for several years) would reduce the need for brushing and weeding for conifer release. Seeding an area with a grass/clover/legume mixture to inhibit some shrub growth may be alternative. This could provide food and cover for prey populations and may reduce the need for brush control.

Relating marten populations to the amount of habitat available is important for both monitoring the effects of research and enhancement programs. Therefore developing population indices for marten could also be a research focus.

However, as much as marten habitat has been described, alternatives for producing marten habitat in second-growth stands should be determined. On a short-term basis retaining blocks of mature timber gives only temporary solutions, although these areas do provide refugia for marten populations. Creating important marten habitat characteristics should remain the focus for research and enhancement.

4.4 Lynx

Lynx habitat use, habitat impacts, and population dynamics are discussed in conjunction with snowshoe hare requirements because of the dependence of lynx on hares as a prey species. Therefore, lynx research requirements and enhancement are considered in relation to patterns and trends of snowshoe hare abundance.

Snowshoe hares prefer diverse forests with alternative stands of conifer for cover and shrubby openings for feeding. Upland forests dominated by aspen support high densities of both hare and lynx. In conifer dominated habitats, dense softwoods in association with openings of 2-4 ha are considered ideal. Use of conifer habitat increases during summer and an irregular pattern of logging or fire is suggested in boreal forests to produce prime hare and lynx habitat as long as forest succession is allowed to continue in a normal pattern. Mature spruce-subalpine fir forests are preferred denning habitats and often have a high number of downed logs. Lynx have been found to select areas dominated by lodgepole pine and spruce-subalpine fir forests and avoid xeric sites and open meadows so any enhancement or research should be focused on this type of habitat. Boreal mixed wood forests provide a more heterogenous and disturbed (logged or burned) environment. Special habitat requirements for hares are thickets of alder, willow, and young conifers and the presence of hollow logs.

There have been little significant lynx population monitoring or research projects in B.C., to date. Since the species is considered biologically uniform throughout its North American range, usually findings from other areas have been applied to B.C.. Information requirements in B.C. include, a better understanding of snowshoe hare distribution, biology and cycle pattern and the habitat requirements and relationships for both hares and lynx in those areas. Further research is required to determine precise habitat protection requirements and enhancement possibilities for lynx (and hare). The largest potential for habitat-related impacts on lynx is the forest industry and some forestry topics for research include:

1) fire suppression, since it may limit production of new hare habitats,
2) compatibility of hare habitat enhancement and forestry/silviculture objectives,
3) cutblock size and juxtaposition with adjacent habitats, and
4) silvicultural treatments (i.e. herbicides) that may affect hare production.

Research is required to determine what constitutes the suitable interspersion of a mature forest for cover and openings (young seral stages) for prey. Characteristics of mature forests that provide cover and denning should be determined and methods to recreate these characteristics in second-growth forests is important. The significance of refugia needs to be determined, as does habitat quality and quantity related to population numbers.

Enhancement involves the creation of early successional forests as habitat for prey within uniform mid-to-late seral conifer stands (especially lodgepole pine) by creating openings.

4.5 Fisher

There was a lack of literature on fisher. Fisher are found in mixed forests with a diversity of tree sizes and ages. The availability of food appears to the most important factor in governing habitat selection. Overhead cover and denning sites are important and maternal dens are usually found in large deciduous trees. Fishers utilize ecotones and edges between different habitat types and riparian areas. Fishers do not appear to be as dependent on climax coniferous forests as marten. Fishers generally occur at mid-elevations and have not been observed making seasonal changes in elevation. A high degree of diversity and interspersion appears to be critical habitat requirements for fishers. The 'best' habitat for fishers is multi-aged stands interspersed with openings and wetland or riparian areas. Other studies suggest that fishers may be better adapted to deciduous and transitional habitat rather than northern conifer forests. The ideal habitat in Oregon was described as dense mature forests, close to climax, with a large percentage of coniferous trees and many windfalls.

Fishers travel extensively whenever there is shallow snow or hard crust conditions. Travel is hindered by deep, soft snow, but when deep snow is present, fishers select coniferous areas where travel is easier due to reduced snow depths. During mid-winter conditions of soft, thick snow, coniferous ridges were the most important winter habitat component for fisher and this appears to relate to prey availability (snowshoe hare).

Severe and extensive disturbance by logging or fire may seriously reduce coniferous forest stand habitat value for fishers, especially during winter due to lack of overhead cover and greater accumulations of snow. Fisher avoid use of large clear-cuts, except for foraging in the summer.

The quality of fisher habitat likely declines when stand composition is greater than 75% conifers. Mature hardwoods may still be required for natal dens and resting sites. Creation of small openings that reduce canopy closure to near 50% helped maintain diversity and the abundance of prey.

Reserves of logged and untrapped wilderness have been important in the re-establishment of fisher populations. Such reserves not only provide undisturbed populations as a source of dispersing fishers for trapped regions but are insurance against population reductions.

Since an essential component of fisher habitat use appears to be diversity, the impacts of clear-cut logging on fisher may be decreased by limiting the size of clear-cuts, encouraging irregularly shaped cuts, maintaining forested cover on ridgelines and retaining and encouraging cover in cutovers to provide for fisher prey. Either retaining or creating snags and hollow trees for den sites is critical. Uneven-aged forest management is an important tool to help maintain fisher habitat requirements. As for marten, although clear-cuts are used in the summer, smaller clear-cuts in various shapes will affect fisher habitat less than creating large uniform clear-cuts.

Research applicable suggestions for the Williston Lake watershed include (in order of priority):

1) analysis of population status relating population numbers to both habitat quality and quantity and habitat changes (developing accurate inventory methods is an important part of this process),
2) identification of critical habitat requirements, and methodology of incorporating these characteristics in second-growth forests,
3) determination of densities in representative habitats,
4) development of a population model to predict the effects of differing harvest regimes,
5) determination of density and habitat use by radio-telemetry, and
6) development of HSI models to predict the capability of habitats based on information provided on forest cover maps. This should include establishing a protocol for testing, refining and validating models.

Specific enhancement options include leaving carcasses in areas of high fisher density in the winter for fisher food and to aid pregnant females. (Ask the trappers where high fisher densities occur.) Encouraging the growth of cover (either silvicultural or using alternative techniques such as planting grasses) in cutovers will provide suitable habitat conditions for fisher prey. Creation of small openings in even-aged serai stands to reduce canopy closure will help maintain diversity and the abundance of a variety of prey. Leaving slash piles in small openings will help increase prey abundance and creating snags and hollow trees for den sites is critical for fisher use.

4.6 Wolverine

There has been no significant population monitoring or research projects on wolverine in British Columbia. Wolverine are described as a unique and interesting animal, possibly serving as an indicator of the health and productivity of local environments better than any other species and are believed to be a challenge in resource use and management.

Wolverines commonly occur above the treeline, especially in summer. Wolverine select mature timber and seral lodgepole pine habitat types. Spruce and fir forests are often used for resting and foraging cover in winter. Some individuals descend to lowlands along rivers and lakes that are utilized as ungulate winter ranges. Snow is also considered an important component of a wolverine's seasonal habitat (winter mortalities provide carrion).

Subalpine fir stands are utilized in summer and wolverines often migrate between higher and lower elevations each season. For example, higher elevation sites are used in the summer for cooler temperatures while lower elevations are used in the winter where food is available. Mature or intermediate timber stands are preferred as wolverine habitat, especially edge and ecotonal areas around cliffs, slides, blowdown, basins, swamps and meadows. Cover is an important habitat characteristic since wolverine show a reluctance to cross large openings. Wolverines often skirt the edges or run straight across these areas, contrasting with their meandering travel patterns commonly displayed within timbered areas.

Currently, no particular habitat components or enhancement techniques have been specifically singled out for wolverine. Undescribed refugia are considered to be of major importance to wolverine and research could be focused in describing refugia sizes and characteristics. The presence and variability of wolverine populations relates to the viability of the entire local ecosystem. Broadly focused integrated resource management that promotes and protects biological diversity and richness is required for wolverine.

Research recommendations are widespread for the wolverine including research on species' biology and behaviour, habitat requirements, population dynamics and so forth. Any enhancement for wolverine would be based on the results of research. Currently, the only enhancement in the literature regards is related to have sufficient populations of moose and caribou to provide ungulate carrion during the winter. It has been suggested leaving carcasses along traplines during severe winters would benefit fisher and marten populations. Leaving ungulate carcasses in lowland areas would probably benefit wolverines in both mild and severe winter conditions. During mild winters, carrion would not be as available to the wolverines since the ungulates would not be as stressed or in as poor condition making them more vulnerable to predation.

Leaving travel corridors in logged stands, especially over elevational gradients, could possibly provide a method to improve habitat conditions for wolverine. Limiting cutblock size is also an option. Recreating old-growth habitats in second growth forests may be important but research is required to find out what habitat characteristics are critical or essential.

4.7 Coyote

Most studies on coyote have dealt with predator-prey relationships, generally with the coyote being considered a nuisance predator around agricultural areas. Coyotes are found to occupy a broad range of habitats, from grasslands to boreal forests and are most frequently found in parkland, alpine tundra, desert, open prairie and thinned timber stands. Specific habitat components of the coyote may include hunting runways, denning areas and migratory routes in mountainous areas.

With a predator as adaptable as the coyote, any habitat that has an abundance of prey species is likely to be used. The coyote's adaptability is due to both its flexibility in hunting and feeding habits. Areas that have been burned, logged or opened and have abundant 'edge' provide habitats for a variety of prey species and are utilized by the coyote. Alteration of wildlife habitat is not as critical for coyote as it is for other wildlife species.

Research topics for coyotes are limited. Assessing the distribution of clear-cuts in space and time is important to maintain a diverse food resource for coyotes. The timing and kind of treatment applied, especially as it affects the viability of plants, may have direct or indirect effects on coyote populations. Other research topics include the development of new census techniques (since there is a lack of inventory data) and some biological research on the coyote in B.C. (since little exists).

Enhancement of coyote populations is not considered necessary since they are so adaptable and they can inhabit nearly all habitat types within the province. Currently, coyotes within B.C. are not known to depress other wildlife populations on a long term basis, and site specific management techniques for coyote populations could restore the balance between coyote and prey populations if problems occur.

4.8 Fox

The red fox is reported to utilize edges and live in semi-open parkland habitat. In upland areas, foxes use open meadows interspersed with groves. The worldwide distribution of foxes clearly indicates that the species can survive in a wide variety of habitats including mountainous settings, boreal forests and interior grasslands. In developed regions foxes are found in agricultural areas where woodlots are interspersed with croplands and grass pasturelands. These areas provide an abundance of prey species as well as denning sites. Competition with other canids and the availability of suitable year-round food sources limit fox survival. The habitat type determines the availability of suitable year-round food resources and the presence or absence of other canids.

There is a need to better understand fox population dynamics. Methods to estimate population changes (and thus determine an allowable harvest) remain priorities. Red fox management has been more "exact" than other furbearers since many studies have been done improving the understanding of spatial and social behaviour of foxes. However, few studies to date have been completed in northern B.C.

4.9 Weasel

Long-tailed weasels appear to be restricted to transition zones between aspen parkland and boreal forest. Boreal forests do not appear to contain the diversity of preferred prey species. Long-tailed weasels appear to be closely associated with free standing water.

The short-tailed weasel is most abundant in boreal, montane and Pacific coast mountains. It appears to avoid dense forests, but settles in successional, forest-edge habitats, or riverbanks with high densities of small mammals. They are uncommon in pine-grown sand ridges and rolling uplands but common in lower spruce-aspen parklands, streamside coniferous belts, and grassy, semi-wooded swamplands.

Short-tailed weasels show a preference for early successional communities such as grasslands and shrubs. In contrast, long-tailed weasels show a trend toward more advanced seral stages and were more general in their habitat preferences. In areas of sympatry, the long-tailed weasel is less abundant and found in more open habitats.

The ecology and behaviour of weasels are less well-known than that of other furbearers and additional research is needed in many areas. This includes particular emphasis on long-term studies of demography and the dynamics of populations in different environments. Methods of estimating populations for proper assessment of an allowable harvest should be developed. More research needs to be conducted on the role of weasels in communities, including mechanisms that enable coexistence with other species. Also, the behaviour of individuals needs more research, particularly foraging behaviour, activity patterns and home ranges as they relate to available resources.

Long-tailed weasels are earmarked for research since trends indicate populations have been steadily declining since the 1930's in Canada. (This however relates primarily to urban and agricultural development in prairie provinces aspen parkland). Short-tailed weasels are also declining due to habitat loss though not as dramatically as long-tailed weasels.

Ecology and population studies are considered important research topics as well.

4.10 Wolf

Little information is available on wolf habitat requirements. Wolves are not restricted to specific habitats and the presence of wolves is dictated by the availability of habitat for prey species. Suitable denning habitat appears to be of secondary importance and in forested areas, dens are generally found in elevated sites with good drainage within 500m of waterbodies. Dens can also be found in rock crevices, beaver lodges, hollow logs and overturned stumps.

Many of the more current publications in B.C. are based on wolf-prey dynamics and at this point, enhancement for wolves is not required. Research would only be important if wolves began to impact significantly on prey populations. This is beyond the scope of the current problem analysis.

5.0 Summary of Interviews with Resource Managers and Furbearer Specialists

Wildlife and forestry resource managers were contacted to discuss any concerns they may have regarding upland furbearers. Although many had fairly specific comments, only the most frequent remarks or concerns have been included in this section. (Further details are found in Appendix 9.3).

Inventories of furbearers are considered an important research topic and this includes developing cost effective, innovative techniques (i.e. using remote cameras) for inventory. Relating population numbers to habitat abundance and quality was considered a high priority. (Fisher, wolverine, lynx and marten need reliable inventories and the success of any enhancement or research programs can be monitored by population responses).

Another high priority research and enhancement topic was the development of critical habitat characteristics in regenerating stands. This is particularly important for a species such as marten, which is considered to be dependent on late successional or old-growth forests. If the specific habitat characteristics vital to marten can be produced in second-growth stands, then marten habitat could be increased in areas with limited mature timber.

Specific research projects were suggested for lynx including characterizing lynx denning habitats and forestry impacts on lynx and snowshoe hare habitats. Any research topic on wolverine and fisher was targeted because so little is known in terms of habitat use or enhancement. Marten were identified to be thoroughly researched and were considered as an important species for testing HSI models and developing population inventory techniques.

Assessing the impacts of forestry practices on furbearer habitat and how to make these positive impacts was also considered a high research priority. Alternative practices to clear-cutting (i.e. selective logging, green tree retention, shelterwood systems) should be researched for feasibility and impacts on furbearer habitat. Research into alternative forestry practices to enhance habitat and enhance forestry values is important.

Many forestry personnel were looking for a practical interpretation of furbearer habitat requirements for management prescriptions or guidelines. Although, it is difficult to put "biology" into specific numbers, at least this type of approach would have all parties working from the same information base. For example, if coarse woody debris is to be left, how much should be left and should it be left in piles or rows? If travel corridors are to be left connecting cutblocks, how large should they be? What years should brushing and weeding be done in early seral stage stands when the hare/lynx cycle is low, thereby impacting the fewest numbers? These information bases can be upgraded as new information regarding species habitat interactions and innovative habitat/forestry management techniques are discovered.

To develop these prescriptions, (as previously mentioned) research is required to define many more species habitat relationships and what impact various habitat management practices have on furbearers and what different techniques can be applied to minimize these impacts. Also, many techniques that are used to enhance furbearer habitat also enhance forestry production. In discussing alternative techniques to brushing and weeding stands at the trappers' meeting, seeding clear-cuts with clover, grasses, and legumes while planting conifers may effectively inhibit the grow of some shrub species. The seeded mixture would provide forage and cover for small mammals that many furbearers rely on. It could also provide some cover for furbearers and allow the conifers to grow relatively unimpeded. If brush species do eventually reinvade the plantation, hopefully the conifers will have reached sufficient size not to have inhibited growth. Additionally, some spring forage for ungulates could be supplied.

Much of the research should be "integrated" as parts of the "whole" picture. Rather than having five studies look at the impacts of harvesting on one species, one study could look at habitat requirements specific to northern B.C. for the species, while another study looks at how different types of harvesting affects the species and what alternatives are feasible. At-the-same-time, a third study could focus on integrating management activities in time and space using modelling, and so forth. The separate pieces should fit together as "pieces" of a puzzle rather than just creating the same puzzle piece over and over. Many trappers wanted to see a logical reporting process followed during research (i.e. problem analysis -> working plan -> progress reports -> job completion reports). Research could also be completed using graduate students and should be cooperative ventures with universities such as UNBC.

6.0 Summary of Trapper Questionnaire

6.1 Introduction

Of the 82 questionnaires sent out (5 were returned unopened) and 25 (30%) were returned in various stages of completeness. Although the survey was developed with the aid of a trapper (Chico Crossland), for some questions, it was difficult for the trappers to understand what was actually being asked of them. Some questions were more 'opinion' oriented than research oriented and were not specifically relevant to the problem analysis. These questions were asked because they were requests from the trappers (if they are going to help the WWCP, it is important to pay attention to their requests) or to find out how trappers felt about certain issues in the trapping industry. If many trappers are disgruntled with the trapping industry as a whole, they are less likely to cooperate with any enhancement or research efforts the WWCP may undertake (i.e trappers can help monitor populations trends through harvest data and so forth in areas of enhancement or research).

The questionnaire was designed to be fill-in-the-blank responses, but ample space was left for trappers to comment. Most trappers are "sick and tired" of answering questionnaires and would prefer some other forum in which to express their views. However, due to the low turnout at the Mackenzie Trappers Association meeting, and the difficulty of actually physically contacting each trapper in the Williston watershed there seemed to be no other way to solicit their opinions.

In summarizing the form, general comment trends were either described or quoted in full dependent on the question. Only relevant questions to the problem analysis are discussed in this summary. (Further details on the entire questionnaire are found in Appendix 9.4).

6.2 Furbearer Populations

The first few questions dealt with the current populations and possible reasons behind population changes for each furbearer on a species basis.

Marten is considered to be common throughout the Williston Lake watershed, but populations are thought to be slowly decreasing. Trappers were mainly concerned with logging practices causing habitat destruction. Many indicated that the marten was "once plentiful but is rapidly disappearing along with the timber". One trapper noted that "after 20 years of logging on my line, marten are down to about 1/3 of previous numbers. My average harvest is 50 to 70 per year where it used to be 150 to 250".

Lynx populations are scarce and generally considered to be slowly decreasing. Trappers indicated either the trapper's area did not have the right habitat for lynx or that silvicultural activities (herbicides, brushing, weeding) eliminate lynx/hare use of an area due to habitat alterations. Some noted " we are in a cycle peak".

Fisher are considered to be extremely scarce and populations are currently not changing. One trapper stated "never was good fisher since we knew it (winter 1937/38)". Opinions were varied on the reasons for fisher decline: either over-harvesting, logging or a combination of both. One trapper sees fisher tracks regularly and avoids trapping them.

Wolverines are considered scarce by most trappers and wolverine numbers are declining.

One trapper mentioned that in "some winters there are 4-5 wolverines and others, there is only 1-2. I believe that depends on snow, temperature and available food". Due to the scarcity of the wolverine many trappers had difficulty commenting.

Coyotes are plentiful and population numbers are either not changing or slowly increasing. The general impression was that coyotes were never common but their numbers may be increasing because of greater prey availability (increased mice in clear-cuts). Coyotes are either increasing or decreasing dependent on "milder winters, garbage dumps, gut piles from Indians and white poaching, lighter snow falls" or "predation due to the wolf population".

Foxes are considered to be common and population numbers are either not changing or slowly increasing. There was a range of comments concerning fox. Some trappers indicated foxes are available periodically but not in large numbers. One trapper mentioned that fox occurred mainly around clear-cuts and another indicated that fox are plentiful since logging has improved the mice population. Fox populations were also reported to go down as coyotes increase. According to a trapper in the Ospika watershed, "fox are not present here".

Weasels are considered to be common and population numbers are either not changing or slowly increasing. There were very few comments on weasels and most dealt with weasel dependency on mice availability. One trapper mentioned that marten "are hard on weasels".

Wolves are considered scarce and the general feeling was that wolf numbers were declining for a variety of reasons including, lack of prey (big game being over-harvested or wolves and bears decreasing the prey stock) or over-hunting. Some trappers thought that wolf numbers were about the same but stated that populations could decline based on climatic conditions and prey populations.

6.3 Habitat Impacts

The major reason suggested for the decline of upland furbearer populations was habitat changes. Specifically, logging, large clear-cuts and silvicultural practices were considered detrimental to furbearer habitat. Lack of prey (due to habitat changes resulting from forestry) was the second most popular answer given regarding furbearer population declines. In some cases, (lynx, fisher, and wolf) natural population cycles were considered to be an additional reason behind population declines.

Interestingly enough, habitat changes (resulting from forestry impacts) was also considered to be the reason for some furbearer increases. For example, fox numbers are considered to be increasing because of the hunting conditions and abundance of certain prey found in clear-cuts. However, furbearers that are increasing in numbers (fox, coyote, and weasel) provide little economic returns for the trappers.

Trappers were asked to indicate which species they felt should have the highest priority concerning research and enhancement (top 5 given):

Research Priorities	Enhancement Priorities
Marten	Marten
Wolverine	Fisher
Fisher	Wolverine
Lynx	Lynx
Fox	Wolf

Most trappers (74%) indicated a willingness to volunteer their time for furbearer research and enhancement. Some comments included: "Yes, I do it quite often by making brush piles for mice and rabbits to hide and feed. I also plant grass seed .." and ".. we have been doing it on our own for years and would love some help".

Trappers were asked to indicate which habitat changes affected their trapping areas the most and ranked the impacts from 9 (highest) to 1 (lowest).

	Rank
Logging/harvesting	9
Forest herbicides	8
Forest fires	7
Silviculture practices (eg. thinning, pruning)	6
Mining	5
Road building	4
Flooding	3
B.C. Hydro lines	2
More people living in the area	1

Note: Forest fires were considered beneficial while the other habitat changes were considered detrimental.

6.4 Additional Comments

Trappers were asked to provide ideas and suggestions for solving habitat issues in the research and enhancement of upland furbearers. To sum up their response, a few representative comments are included. Reading the actual quotes allows the reader to more fully understand the trapper's concerns.

"This question is being answered with my opinion. What I would like to see, first off, the clear cut logging has to stop, or at least make smaller blocks. Selective logging (going in the area every year to take out the bigger trees and leaving everything else alone) and horse-logging is an excellent way because in a couple of years you couldn't tell that they were there. The damage is hardly nothing. I don't believe in herbicides in any way, shape, or form. It kills many small animals needlessly, plus they don't know the long term effects. Road building, B.C. Hydro lines and mining are not too bad, depends on the volume and scale it is being done. Flooding Williston Lake doesn't do any animals any good, plus the lake is dangerous as hell. Small forest fires are good for all animals, big and small. Selective logging is the way to go. Only take the mature timber or the sick (bug kill). In this way no animals have to suffer any effects for logging. Plus we have timber always".

"I believe it is unwise and unrealistic to expect the forest companies to carry out, either horse logging or selective cutting to any degree. Clear-cuts could be smaller i.e. limit 80 hectares. After logging a good, wide smooth fireguard should be cleared around that portion of the perimeter bordering old growth to allow the trapper to utilize this as an access road, it would help us. The current practice of slash burning should be totally ended. When asked why they do it, we are told vaguely something about killing bugs. It baffles me why this is allowed at all what with the ozone crisis. Herbicides should only be applied in hack and squirt".

"Logging, clear-cuts are okay in some areas but selective harvesting can take place in some areas but does not because our system is geared to harvest the forests for quick economic gain. Little regard is given to the wildlife habitat. Our system of forestry has to be completely restructured meaning more value-added products, thus dramatically reducing the rate of harvest. In this way renewable forests and furbearers can be maintained. Less harvest-less silviculture-less herbicide-LESS IMPACT. Lets face it at the current rate of harvest can population that depend on old growth survive"?

"Logging/harvesting: less logging, different logging (no clear-cuts) small strips and big areas not logged, better logging cleaning up, piling, better use of what they take any areas of bare ground in cut blocks should be grass seeded and all roads and landings. Upland willow should be planted with spruce and pine seedlings."

"Smaller clear cuts, strip logging, selective logging. As much debris as possible should be left to imitate natural wind fall and downed timber to create good habitat for rodents and under the snow habitat for marten. If man would observe nature, imitate it and forget about improving it. Nature has much longer training at this. Man is a slow learner because he does not accept the fact that mother nature knows best".

7.0 Enhancement and Research Matrices

7.1 Introduction

Of the eight upland furbearers in the Williston Lake watershed, four species (marten, wolverine, lynx and fisher) were considered important for either research and/or enhancement. Although wolf, coyote, weasel and fox are important as furbearers, research and enhancement is not considered a priority at this time. Additionally, predators such as wolves have so much potential to impact ungulate populations, discussing wolf research is beyond the scope of the problem analysis.

The three major biogeoclimatic zones in the Williston Lake watershed are SBS, ESSF, and BWSB. The greatest diversity and abundance of furbearers occur in these zones and any research or enhancement should be conducted in these areas (unless otherwise stated).

Any enhancement or research program carried out will require some method of evaluation (ie. Is the objective of the program met?). Species numbers (populations) or abundance (numbers of species) are possible indicators of a program's success.

7.2 Research Topics

Each research opportunity has been ranked based on the amount of information currently available: 1 [abundant information] to 4 [little or no information](Table 1). Consequently, the furbearer with the highest total has the greatest opportunity for research since so little is currently known. Concurrently, the lowest total identifies the species with the greatest opportunity for enhancement since the most information is available.

Table 1. Research opportunities for upland furbearers.

RESEARCH OPPORTUNITIES	UPLAND FURBEARER SPECIES			
	Marten	Wolverine	Lynx	Fisher
Habitat requirements (certain habitat components, structural characteristics, forest types)	1	4	2	2
Methods of creating specific habitat components (in different *seral* stages or habitat types)	3	4	2	4
Impacts of habitat changes (including logging)	1	4	3	3
Impacts of other forestry practices	1	4	2	3
Inventory needs	4	4	4	4
Importance to trappers	4	2	3	1
Enhancement opportunities	3	3	3	3
Development and testing of HSI models	1	4	3	3
Development of specific guidelines for management and enhancement of furbearer habitat	2	4	3	3
Total for each species	19	33	24	30

7.3 Enhancement Topics

Enhancement opportunities describe possible methods to rehabilitate or improve areas for upland furbearer habitat. Many of these areas may already have been subject to some habitat changes (i.e. logging) and enhancement will involve recreating some pre-harvest features in second-growth stands at various seral stages. Many enhancement techniques will come as a result of research and will be further expanded as techniques are tested and refined. However at this point, enhancement options are somewhat limited.

Analogous to the research matrix, each enhancement opportunity has been ranked based on the amount of information currently available (Table 2). The furbearer with the lowest total has the greatest opportunity for enhancement.

Table 2. Enhancement opportunities for upland furbearers.

ENHANCEMENT OPPORTUNITIES	UPLAND FURBEARER SPECIES			
	Marten	Wolverine	Lynx	Fisher
Create relatively small clear-cuts of irregular shape within mid-to-late seral coniferous forest so some habitat is in early/mid successional stages	2	4	1	2
Create CWD (brush piles, piles of small logs) in either clear-cuts or small openings within seral stage forests	1	4	2	1
Leave or create travel corridors in areas to be harvested, brushed and weeded or herbicided areas (i.e. any area that is to be treated should have leave strips or untreated area	2	1	3	2
Manual brushing of herbaceous vegetation to encourage vigourous re-sprouting	2	3	1	3
Seed recent conifer plantations areas with clover or grass mixtures	2	3	1	3
Potential snag creation by cutting off tree tops, maintaining snags during silvicultural operations etc.	1	4	3	1*
Re-creating the effects of fire by creating habitat mosaics	1	1	1	1
Total	11	20	12	13

* For fisher, snag creation should be in deciduous trees.

The difficulty of trying to discuss enhancement options is that many of the 'enhancement' options are actually part of the planning/management process. For example, maintaining snags during harvesting is important for species such as marten and fisher, and thus will provide some life requisites in these areas after logging is completed. Furthermore, selected stands or groups of existing snags or defective trees should be left within intensively managed forests on rotations of sufficient length to ensure habitat diversity and a future source of snags and debris. In order that future forest management practices are worthwhile and effective for furbearers, research is required to identify specific habitat requirements and, subsequently, create or maintain these habitat factors in managed stands.

7.4 Recommendations and Conclusions

The conflicts between forest and wildlife resource management regarding furbearers has generated some research into the habitat requirements and effects of forestry and other practices on some furbearer species. However, there is a lack of habitat and population information on furbearers in the Williston Lake watershed. Additionally, little research has examined ways to minimize impacts on furbearer habitat or methods to manipulate stands to provide structural characteristics important to furbearers.

Much of the research has emphasised the identification of critical habitat needs and population inventories. Additionally, how forestry practices impact furbearers and their prey species has been studied. More information is required to determine the development of critical habitat components thereby ensuring species survival and the enhancement of furbearer populations in the Williston Lake watershed.

In order of priority, habitat related research was required for wolverine, fisher, lynx, and marten. Marten has the most opportunity for enhancement since the most information is known on habitat requirements; wolverine had the most opportunity for research since so little is currently known.

Additionally, the challenge is to help develop or modify existing forestry practices to benefit both furbearers and timber production. Ultimately, this will contribute to the overall biodiversity found in the Williston Lake watershed.

8.0 Literature cited

Allen, A.W. 1982. Habitat suitability index models: Marten. U.S. Dep. Inter. Fish and Wildl. Serv. 14 pp.

———. 1983. Habitat suitability index models: fisher. United States Fish and Wildlife Service, Biol. Services Program. FWS/OBS 82/10.45. 19 pp. Cited in Banci 1989 and Thomasma et al. 1991.

———. 1984. Habitat suitability index models: marten. U.S. Fish and Wildlife Service, FWS-OBS-82/10.11 Revised, Fort Collins, Colorado

Andelt, W.F., J.G. Kie, F.F. Knowlton and K. Cardwell. 1987. Variation in coyote diets associated with season and successional changes in vegetation. J. Wildl. Manage. 51(2):273-277

Archibald, W.R. 1989 Wolf Management in B.C. in Wolf- Prey Dynamics and Management. Proceedings of a symposium held May 10 & 11, 1988 at the University of B.C. B.C. Min. of Environ., Min. of For., and Northwest Wildlife Preservation Society. B.C. Min. of Environ. Wildlife Working Report No. WR-40.

———, and R.H. Jessup. 1984. Population Dynamics of the pine marten (Martes americana) in the Yukon Territory. Pages 21-97 in R. Olsen. et al (ed.). Northern Ecology and Resource Management. The University of Alberta Press, Edmonton.

Arthur, S. M., W.B. Krohn, and J.R. Gilbert 1989. Habitat Use and Diet of Fishers. J. Wildl. Manage. 53(3):680-688

Aubry, K.B. 1984. The recent history and present distribution of the red fox in Washington. Northwest Science, Vol. 58, No. 1.

Bailey, T.N., E.E. Bangs, M.R. Former, J.C. Malloy, and R.J. McAvinchey. 1986. An apparent overexploited lynx population on the Kenai Peninsula, Alaska. J.Wildl. Manage. 50:276-289.

Baker, J.M. 1992. Habitat use and spatial organization of pine marten on southern Vancouver Island, British Columbia, unpubl. thesis.Simon Fraser University 133 pp.

Balke, J., S. Mooney, D. Becker, and G. Suther. 1992. Biodiversity: A Review. Phase I of the Quadra Island Biodiversity Sampling Project. Unpbl. rep. for B.C. Min. of Environment. 100 pp.

Banci, V. 1989. A fisher management strategy for B.C. Wildlife Bulletin No. B-63 Ministry of Environment, Wildlife Branch, Victoria, B.C. 117 pp.

——. 1990. Management of Furbearer Populations in British Columbia. Unpbl. rep. presented at the Northwest Furbearer Symposium, Cranbrook, B.C. 11 pp.

———, and A. Harestad 1988. Reproduction and Natality of wolverine (Gulo) in Yukon Naa. Zool. Fennici 25:265-270.

Banfield, A.W.F. 1974. The mammals of Canada. University of Toronto Press.

Bateman, M.C. 1986. Winter habitat use, food habits and home range size of the marten, Martes americana, in western Newfoundland. Canadian Field-Naturalist 100: 58-62.

Bekoff, M. 1982. Coyote. Pages 447-459 in J.A. Chapman and G.A. Feldhamer, eds. Wild mammals of North America: biology, management, and economics. Johns Hopkins Univ. Press, Baltimore,Md.

Bergerud, A.T. 1971. The population dynamics of Newfoundland caribou. Wildlife Monographs, No. 25, 55 pp.

——, and J.P. Elliot. 1986. Dynamics of caribou and wolves in northern British Columbia. Can. J. Zool. 64:1515-1529.

Berrie, P.M. 1973. Ecology and status of the lynx in interior Alaska. Pages 4-41 in R.L. Eaton (ed.). The Worlds Cats, Vol. I. World Wildlife Safari, Winston, Oregon.

Biggs, W.G. and M.E. Walmsley. 1988. Research requirements to determine the effects of silvicultural herbicides on wildlife habitat: a problem analysis. Can. For. Ser. and B.C. Min. For. FRDA 040

Bissonette, J.A., R.J. Fredrickson and B.J. Tucker. 1989. American marten: a case for landscape-level management. Transactions 54th North American Wildlife and Natural Resources Conference 54: 89-100.

Blood, D. 1988. Research Priorities for Furbearers in British Columbia. 40 pp.

Bowen, W.D. 1982. Home range and spatial organization of coyotes in Jasper National Park, Alberta. J.Wildl. Manage. 46(1):201-206 Wildlife Working Report No. WR - 32. 49 pp.

Brainerd, S.M. 1990. The pine marten (martes martes) and forest fragmentation: a review and general hypothesis. Transactions of the 19th Congress of the International Union of game Biologists, Trondheim, Norway.

Brand C.J. and L.B. Keith 1979. Lynx demography during a snowshoe hare decline in Alberta

B.C. Fish and Wildlife Branch. 1979. Preliminary wolf management plan for British Columbia. 30 pp. Cited in Archibald 1989.

B.C. Wildlife Branch. 1980a. Preliminary Coyote Management Plan for British Columbia. Ministry of Environment, Province of B.C. 24 pp.

——. 1980b. Preliminary Fox, Raccoon, and Squirrel Management Plan for British Columbia. Ministry of Environment, Province of B.C. 15 pp.

B.C. Ministry of Environment. 1991. B. C.'s Environment Planning for the Future. Managing Wildlife to 2001:A Discussion Paper. 152 pp.

British Columbia Trappers Association. 1989. Unpublished report, Forest Management Policy. 3 pp.

Buskirk, S.W. 1984. Seasonal use of resting sites by marten in south-central Alaska. Journal of Wildl. Management 48: 950-953.

——, H.J. Harlow, and S.C. Forrest. 1987. Studies on the resting site ecology of marten in the central Rocky Mountains. Pages 150-153 in C.A. Troendle, M. R. Kaufmann, R.J. Hamre and R.P. Winokur. Management of subalpine forests:building on 50 years of research. Society of american Foresters Publication SAF 87.08, USDA Forest Service General Technical Report RM-149, Silver Creek, Colorado.

------, and L.L. McDonald . 1989 Analysis of variability in home-range size of the American marten. Journal of Wildlife Management 53: 997-1004.

——, S.C. Forrest, M.G. Raphael, and J.J. Harlow. 1989. Winter resting site ecology of marten in the central Rocky Mountains. Journal of Wildlife Management 53: 191-196.

Campbell, T.M.,III 1979. Short-term effects of timber harvests on pine marten ecology. M.S. Thesis, Colorado state Univ.,Fort Collins . 76 pp. Cited from Snydor and Bissonette 1987.

Carbyn L.W. 1982. Coyote population fluctuations and spatial distribution in relation to wolf territories in Riding Mountain Nationai Park, Manitoba. Canadian Field-Naturalist 96(2): 176-183

---------. 1987. Gray Wolf and Red Wolf. Chapter 29, pages 358-376 in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150 pp.

Child, K. and D. King. 1988. Omineca Sub-regional Wildlife Plan. Ministry of Environment, Northern Interior Region. Unpubl. Report.

Clark, F.W. 1972. Influence of jackrabbit density on coyote habitat change. J. Wildl. Manage. 36(2):343-356.

Clark, T.W., and T.M. Campbell,III. 1977. Short-term effects of timber harvests on pine marten ecology. Terminal Rep. Univ, of Idaho, Moscow. 60 pp.

——, and T.M. Campbell,III. 1976. Population organization and regulatory mechanisms of pine martens in Grand Teton notional Park, Wyoming. Proc. First Conf. Sci. Res. Natl. Parks, U.S. Natl. Park Serv.,Trans. Proc. Ser. 5.1:293-295.

———, E. Anderson, C. Douglas, and M. Strickland. 1987. Martes americana. Mammalian Species No. 289. The American Society of Mammalogists, 8 pp.

———, T.M. Campbell III and T.N. Hauptman. 1989. Demographic Characteristics of American Marten Populations in Jackson Hole, Wyoming.Great Basin Naturalist Vol. 49, No. 4 pp. 587-596.

---------, M. Bekoff, T.M. Campbell, T. Hauptman and B.D. Roberts 1989. American Marten, Martes Americana, home ranges in Grand Teton National Park, Wyoming. The Canadian Field Naturalist Vol. 103(3) pp. 423-425

Corn, J.G and M.G. Raphael. 1992. J. Wildl. Manage. 56(3):442-448 Habitat characteristics at marten subnivean access sites.

Dagg, A.I. and G.A. Campbell 1974. Historic changes in the distribution and numbers of wolverine in Canada and the northern United States. Unpbl. Rep., Can. Wildl. Serv., Ottawa. 21 pp. Cited in Hornocker and Hash 1981.

Davidson, P. and R. Dawson. 1990. Williston Wildlife Compensation Program Management Plan. Unpbl. rep. technical document presented to the Williston Compensation Steering Committee. 44 pp.

Davidson, R.P. 1980. The effect of exploitation on some parameters of coyote populations, unpub. Phd thesis. Utah State University. 153 pp.

Davis, T.M. 1992. Sampling Amphibians and Reptiles. Pages 71-72 in Methodology for Monitoring Wildlife Diversity in B.C. Forests. Proceedings of a Workshop. Green Timbers B.C. Forestry Association Education Centre. Surrey, B.C.

Deems,(Jr.) E.F. and D. Pursley. 1978. North American Furbearers. Their Management, Research and Harvest Status in 1976. University of Maryland Press 165 pp.

de Vos, A. 1952. The ecology and management of fisher and marten in Ontario. Ontario Dept, of Lands and forests, Tech. Bull., Wildlife Series I. Toronto, Ontario. 90 pp.

Dodds, D.G. and A.M. Martell. 1971. The recent status of the marten, Martes americana americana (Turton), in Nova Scotia. Canadian Field-Naturalist 85: 61-62.

Douglas C.W. and M.A. Strickland. 1987. Fisher. Chapter 40, pages 511-529 in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150 pp.

Fagerstone, K.A. 1987. Black-footed ferret, long-tailed weasel, short-tailed weasel, and least weasel. Chapter 42, pages 547-573 in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150pp.

Fisher, J. 1975. The plains dog moves east. Natl. Wildl. 13(2): 1417 Cited in Voigt and Berg (1987) in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150 pp.

Flynn, R.W. 1991. Ecology of martens in southeast Alaska. Wildlife Research and Management Project No.:W-23-4 Study No. 7.16, Alaska Department of Fish and Game, Juneau, Alaska. 33 pp.

Fudge & Associates, 1989. The Implications of a small mammal decline on Marten in Labrador and Northeastern Quebec. Technical Report 4-D, Dept, of National Defense, Ottawa, Ontario.

Gier, H.T. 1968. Coyotes in Kansas. Agricultural Experiment Station, Kansas State University of Agricultural and Applied Science. 118 pp.

Golden, H.N. 1987. Survey of furbearer populations on the Yukon Flats National Wildlife Refuge. Final Report. Alaska Department of Fish and Game and U.S. Fish and Wildlife Service, Fairbanks, Alaska. 86 pp.

———. 1988. Distribution and relative abundance, population characteristics, and harvest of furbearers in Gates of the Arctic National Park and Preserve. Final Report. National Park Service, Anchorage Alaska. 86 pp.

Grakov, N.N. 1972. Effect of concentrated clearfellings on the abundance of the pine marten (martes martes L.) - Biulletin - Moskovskoe obshchestvo ispytatelei prirody otdel biologicheskii 77: 14-23. (In Russian,with English summary) Cited in Brainerd 1990.

Hamlin. K.L. 1979. Cooperation by coyote pairs attacking mule deer fawns. J. Mamm., 60(4): 849-850.

--------, S.J. Riley, D. Pyrah, A.R. Dood and R.J. Mackie. 1984. Relationships among mule deer fawn mortality, coyotes, and alternate prey species during summer. J.Wildl. Manage. 48(2):489-499.

Harestad, A. 1992. Monitoring Bats and Furbearers fro Biodiversity Studies. Pages 61-63 in Methodology for Monitoring Wildlife Diversity in B.C. Forests. Proceedings of a Workshop. Green Timbers B.C. Forestry Association Education Centre. Surrey, B.C.

Hart D. and P.G. Comeau. 1992. Manual brushing for forest management ion British Columbia: a review of current knowledge and information needs. Land Management Report No. 77, B.C. Min of Forests. 36 pp.

Hash, H.S. 1987. Wolverine. Pages 575-585 Cited in M. Novak, et al. 1987.

Hatler, D.F. 1988. A lynx management strategy for British Columbia. Wildlife Working No. WR-34, Ministry of Environment, Victoria. 115 pp.

——. 1989. A wolverine management strategy for British Columbia. Wildlife Bulletin (British Columbia Wildlife Branch; no.B-60).

-------. 1991. A method for Monitoring Wildlife in Managed Forests A Field Manual (First Approximation). Can. For. Ser. and B.C. Min. For., FRDA Rep 172. 55 pp.

Hebert, D. 1987. Quesnel Highlands wolf control project. B.C. Ministry of Environment Wildlife Working Report No. WR-26. 10 pp.

Henry, S.E., M.G. Raphael and L.F. Ruggiero 1990. Food caching and handling by marten. Great Basin Naturalist 50(4), 1990, pp.381-383

Hoffman, S.W. 1979. Coyote-prey relationships in Curlew Valley during a period of low jackrabbit density. Unpub. MSc. thesis Utah State University, Logan, Utah 139 pp.

Hopwood, D. 1991. Principles and Practices of New Forestry. A guide for British Columbians. B.C. Min. of For. Land Management Report No. 71. 95 pp.

Hornocker, M.G. and H.S. Hash. 1981. Ecology of the Wolverine in northwestern Montana Can. J. Zool. 59:1286-1301.

Ingram, R. 1973. Wolverine, fisher, and marten in central Oregon. Oreg. State Game Commission, Central Region Administrative Rep. No. 73-2. 41 pp. Cited in Banci 1989.

Janz, D. 1987. Vancouver Island wolf control project. Year 1 progress report. B.C. Ministry of Environment Wildlife Working Report No. WR-28.

Johnson,S.A. 1984. Home range, movements, and habitat use of fishers in Wisconsin. M.Sc. Thesis. Univ, of Wisconsin, Stevens Point. 78 pp. Cited in Banci 1989.

Jones D.M. and J.B. Theberge. 1982. Summer home range and habitat utilization of the red fox (Vulpes) in a tundra habitat, northwest British Columbia. Cna. J. Zool. 60:807-812.

Keith, L.B. and L.A. Windberg. 1978. A demographic analysis of the shoeshoe hare cycle. Wildlife Monographs 58: 1-70.

Kelly, G.M. 1977. Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas. Ph.D. Thesis. Univ, of Massachusetts, Amherst. 778 pp.

Kelly. J.P. 1975. A historical review of the interest and management of fur trapping in North Central B.C.Fish and Wildlife Branch, Victoria, B.C. Unpub. report 122 pp.

——. 1982. Impacts of Forest Harvesting on the Pine Marten in the Central Interior of B.C. M.Sc. Thesis University of Alberta 54 pp.

Kelsall, J.P., E.S. Telfer and T.D. Wright 1977. The effects of fire on the ecology of the Boreal Forest, with particular reference to the Canadian north: a review and selected bibliography. Canadian Wildlife Service, Occasional Paper Number 323.

Koehler, G.M. 1975. The effects of fire on marten distribution and abundance in the Selway-Bitterroot Wilderness. M.S. Thesis. University of Idaho, Moscow. 26 pp.

——. 1987. The Ecology of the Lynx (Lynx cnandensis) in North-central Washington. Unpubl. Prog. Rep., Wildl. Res. Inst., Univ. Idaho, Moscow. 25 pp.

——. 1990. Population and habitat characteristics of lynx in north central Washington. Can. J. Zool. 68: 845-851.

——, and M. G. Hornocker.1977. Fire effects on Marten Habitat in the Selway-Bitterroot J. Wildl. Manage. 41(3):500-505.

———, M.G. Hornocker, and H.S. Hash. 1979. Lynx movements and habitat use in Montana. Can. Field-Nat. 93:441-442.

——, J.A. Blakesley, and T. W. Koehler. 1990. Marten use of successional forest stages during winter in north-central Washington. Northwestern Naturalist 71:1-4.

Kuehn, D.W. 1989. Winter foods of fishers during a snowshoe hare decline 1989. J.Wildl. Manage. 53(3):688-692.

------, and W.E. Berg. 1979 (ms). Fisher in Minnesota. Pages 118-120 in Douglas, C.W., and M.A. Strickland, eds. Trans, of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset, Ont.,21-23 Oct 1979. Cited in Banci, V. 1989. A fisher management strategy for B.C. Wildlife Bulletin No. B-63 Ministry of Environment, Wildlife Branch, Victoria, B.C. 117 pp.

Laundre', J.W. and B. L. Keller. 1981. Home-range use by coyotes in Idaho. Anim. Behav. 29:449-461.

Lensink, C.J., R.O. Skoog, and J.L. Buckley. 1955. Food habits of marten in interior Alaska and their significance. Journal of Wildlife Management 19: 363-368.

Loforth, E.G. and J.D. Steventon. 1990. Managing for marten winter in interior forests of British Columbia. Proceedings, Wildlife/Forestry Symposium, Canadian Forestry Institute, Prince George, British Columbia.

——, and V. Banci. 1991. Marten Habitat Suitability Research Project Working Plan. Wildlife Branch, Ministry of Environment, Victoria, B.C. Wildlife Working Report No. WR-50. 27 pp.

Magoun, A.J. 1985. Population characteristics, ecology, and management of wolverines in northwestern Alaska. Unpubl. PhD Thesis, Univ. Alaska, Fairbanks 197 pp.

——. 1987. Summer and winter diets of wolverines, Gulo gulo, in arctic Alaska Can. Field-Nat. 101:392-397.

——. 1991. Marten in Early Successional Habitats created by wildlife in Interior Alaska: are we ready for HSI Models? Prepared for Nowitna National Wildlife Refuge, Galena, Alaska 99741.

——, and D.J. Vernam. 1990. More About Marten use of Forest Openings. Bureau of Land Management. Anchorage, Alaska. 10 pp.

Martelle, M. 1990. Potential Responses of Marten Habitat Carrying Capacity to Future Timber Harvests in a Northern Ontario Forest. NWOFTDU Miscellaneous Report #06. 80 pp.

Marten, S.K. and R.H. Barrett. 1991. Resting site selection by marten at Sagehen Creek, California. Northwestern Naturalist 72:37-42.

Maser, C. and J.M. Trappe (editors). 1984. the seen and unseen world of the fallen tree. USDA For. Serv., Pac. Northwest Forest and Range Exp. Sta., Portland, Oregon, in coop, with USDI, Bur. Land. Manage. Gen. Tech. Rep. PNW-164. Cited in Martelle 1990.

Mech, L.D. 1980. Age, sex, reproduction, and spatial organization of lynxes colonizing in northeastern Minnesota. Journal of Mammalogy 61: 261-267.

——, and L.L. Rogers. 1977. Status, distribution, and movements of martens in northeastern Minnesota. USDA Forestry Service Research Paper NC-143, North Central Forest Experiment Station, St. Paul, Minnesota. 7 pp.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. B.C. Ministry of Forests. 330 pp.

Messier, F., C. Barrette and J. Huot. 1986. Coyote predation on a white-tailed deer population in southern Quebec. Can. J. Zool. 64: 1134-1136

——, and C. Barrette. 1982. The social system of the coyote (Canis latrans) in a forested habitat. Can. J. Zool. 60:1743-1753.

More, G. 1976. Some winter food habits of lynx in the southern Mackenzie District, Northwest Territories . Can. Field-Nat. 90:499-500.

Morrison, M.L. and E.C. Meslow. 1983. Impacts of forest herbicides on wildlife: Toxicity and habitat alteration. Transactions of the 48th N. Am. Wildl. Conf., pp. 175-185. Cited in Biggs and Walmsley 1988.

Murie, O.J. 1945. Notes on coyote food habits in Montana and British Columbia. J.Mamm. 26(1):33-40 Nellis C. H. and L.B. Keith 1967. Population dynamics of coyotes in central Alberta, 1964-68. J. Wildl. Manage. 40(3):389-399.

Nellis, C.H. and L.B. Keith. 1976. Population dynamics of coyotes in central Alberta, 1964-68. J. Wildl. Manage. 40: 389-399.

Novak,M., J.A. Baker, M.E. Obbard, and B. Malloch (eds.). 1987. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario. 1150 pp.

Nyberg, J.B., F.L. Bunnell, D.W. Janz and R.M. Ellis. 1986. Managing young forests as black-tailed deer winter ranges. B.C. Min. of For.,Victoria, B.C. Land Manage. Rep. 37O. O'Connor (1984) see Hatler for reference.

O'Connor, R.M. 1984. Population trends, age structure, and reproductive characteristics of female lynx in Alaska, 1961 through 1973. Unpbl. M.S. Thesis, Univ. Alaska, Fairbanks. 111 pp.

Ozoga, J.J. and E.M. Harger. 1966. Winter activities and feeding habits of northern Michigan coyotes. J. Wildl. Manage. 30(4): 809-818

Quick, H.F. 1955 Food habits of marten (martes americana) in northern British Columbia. Canadian Field-Naturalist 69:144-147.

Quinn, N.W.S. and G. Parker. 1987. Lynx. Pages 683-694 in M. Novak, J.A. Baker, M.E. Obbard and B. Malloch (eds.) Wild Furbearer Management and Conservation in North America. Ontario Min. of Nat. Resources, Toronto.

——, and J.E. Thompson. 1985. Age and sex of trapped lynx, felis canadensis, related to period of capture and trapping technique. Can. Field-Nat. 99:267-269.

——, and J.E. Thompson. 1987. Dynamics of an exploited Canada lynx population in Ontario. J. Wildl. Manage. 51(2):297-305.

Raine, R.M. 1981. Winter food habits, responses to snow cover and movements of Fisher (Martes Pennanti) and Marten (Martes Americana) in southeastern Manitoba. Unpub. M.Sc. Thesis University of Manitoba 145 pp.

Reichel, J.D. 1991. Relationships among coyote food habits, prey populations, and habitat use. Northwest Science, Vol. 65, No. 3:133-137.

Ritchie, C. and T.P. Sullivan. 1989. Monitoring methodology for assessing the impact of forest herbicide use on small mammal populations in British Columbia. Can. For. Ser. and B.C. Min. For., FRDA report 081.

Rosenzweig, M.L. 1966. Community structure of sympatric Carnivora. J. Mammal. 47: 602-612. Cited in Raine 1981.

Sadoway, K.L. 1986. Effects of intensive forest management on non-ungulate mammals of Vancouver Island: problem analysis. Research, B.C. Ministries of Environment and Forests. IWIFR-24. Victoria B.C.

Salwasser, H. 1985. Integrating wildlife into the manages forest. For. Chron. 61: 146-149. Cited in Martelle 1990.

Schultz, T.T and L.A. Joyce. 1992.A Spatial Application of A Marten Habitat Model. Wildl. Soc. Bull. 20:74-83.

Schwatz, C.C., E. Becker, and K.J. Hundertmark. 1988/1990. see 647. Trostel, K. A.R.E. Sinclair, C.J. Waiters, and C.J. Krebs (1987).Oecologia (Berlin) 74:185-192.

Siderits, K. and R.E. Radtke. 1977. Enhancing forest wildlife habitat through diversity. Trans. North Amer. Wildl, and Nat. Resour. Conf. 42: 425-433. Cited in Martelle 1990.

Simms, D.A. 1979a. North American weasels:resource utilization and distribution. Can. J. Zool. 57: 824-832. Cited in Fagerstone 1987.

Slough, B.G. 1986. Lynx status and management in the Yukon. Interim Rep., Yukon Dep. Renewable Resources, Whitehorse. 15 pp.

——. 1989. Movements and habitat use by transplanted marten in the Yukon Territory. Journal of Wildlife Management 53: 991-997.

Smits, C.M.M., B.G. Slough and G.A. Yasui.1989. Summer food habits of sympatric Arctic Foxes, Alopex lagopus,, and Red Foxes, Vulpes vulpes, in northern Yukon Territory. Canadian Field-Naturalist 103(3): 363-367.

Snyder, J.E. 1984. Marten use of clear-cuts and residual forest stands in western Newfoundland. M.S. Thesis, Univ. Maine, Orono, Maine. 31 pp. Cited in Strickland and Douglas 1987.

——, and J.A. Bissonette. 1987. Marten Use of clear-cuttings and residual forest stands in Western Newfoundland. Can. Journal of Zoology 65:169-174.

Soutiere, E.C. 1979. Effects of timber harvesting on marten in Maine. Journal of Wildlife Management 43: 850-860.

Spencer, W.D., R.H. Barrett and W.J. Zielinski. 1983. Marten habitat preferences in the northern Sierra Nevada. Journal of Wildlife Management 47: 1181-1186.

Stephensen, R.O. 1987. Unpub.Report to the board of Game on Lynx Management, Alaska Department of Fish and Game, Division of Game 30 pp.

Steventon, J.D. and J.T. Major. 1982. Marten use of habitat in a commercially clear-cut forest. Journal of Wildlife Management 46: 175-182.

Strickland, M.A. and C.W. Douglas. 1987. Marten. Pages 531-546 in M. Novak, J.A. Baker, M.E. Obbard and B. Malloch (eds.) Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto.

Sullivan, T.P. 1986. Influence of wolverine (Gulo gulo) odour on the feeding behaviour of snowshoe hares (Lepus amreicanus) J. Mamm., 67(2):385-388.

Tefler, E.S. 1974. Logging as a factor in wildlife ecology in the boreal forest. For. Chron. 50:186-190. Cited in Martelle 1990.

Theberge J.B. and C.H.R. Wedeles 1989. Prey selection and habitat partitioning in sympatric coyote and red fox populations, southwest Yukon. Can J. Zool. 67:1285 - 1290.

Thomasma, L.E., T.D. Drummer and R.O. Peterson 1991. Testing the habitat suitability index model for fisher. Wildl. Soc. Bull. 19:291-297.

Thompson, I.D. 1982. Effects of timber harvesting of boreal forest on marten and small mammals. Can. Wildl. Serv. Progr. Rep. No. 1.

———. 1988. Habitat needs of furbearers in relation to logging in boreal Ontario. Forestry Chronicle 65: 251-261.

——, and P.W. Colgan.1987. Numerical responses of martens to a food shortage in North central Ontario J.Wild. Manage. 51(4):824-835.

—, U. Davidson, S. O'Donnell, and F. Brazeau. 1989. Use of track transects to measure the relative occurrence of some boreal mammals in uncut forest regeneration stands. Canadian Journal of Zoology 67:1816-1823.

———, and P.W. Colgan. 1990. Prey choice by marten during a decline in prey abundance. Oecologia 83: 443-451.

Todd, A.W. 1985. Demographic and dietary comparisons of forest and farmland coyote, Canis latrans, populations in Alberta. Canadian Field-Naturalist 99(2): 163-171.

——. 1985. The Canada lynx: ecology and management. Canadian Trapper 13(2): 15-20.

——, L.B. Keith, and C.A. Fisher. 1981. Population Ecology of Coyotes during a fluctuation of snowshoe hares. J. Wildl.Manage. 45(3):629-640.

Toweill, D.E. and R.G. Anthony. 1988. Coyote foods in a coniferous forest in Oregon. J. Wildl. Manage. 52(3): 507-512.

Van Zyll De Jong, C.C. 1975. The distribution and abundance of the wolverine (Gulo gulo) in Canada. Canadian Field-Naturalist 89(4): 431-437.

Verner, J. and A.S.Boss, Tech. Coordinators. 1980. California wildlife and their habitats: western Sierra Nevada. Gen. Tech. Rep. PSW-37, Pacific Southwest Forest and Range Exp. Sta. Forest Serv., U.S. Dep. Agric. Berkeley, Calif. 439 pp.

Voigt, D.R. 1987. Red Fox. Chapter 30, pages 378-392 in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150 pp.

———, and W.E. Berg. 1987. Coyote. Chapter 28, pages 344-357 in: M. Novak et al., eds, Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150 pp.

Von Schuckmann, S. 1986. The implications of brush control to wildlife and fish. Proc. Symp. Vegetation Management Assoc. B.C. Professional Foresters, Vancouver, B.C. Cited in Ritchie and Sullivan 1989.

Weaver, J.L. 1977. Coyote-food base relationships in Jackson Hole, Wyoming. Unpub. MSc. thesis. Utah State University, Logan, Utah. 98 pp.

Weckwerth. R.P. and V.D. Hawley. 1962. Marten food habits and population fluctuations in Montana. Journal of Wildlife Management 26: 55-74.

White, M., R.H. Barrett, A.S. Boss, T.F. Newman, T.J. Rahn and D.F. Williams out of Verner, J. and A.S. Boss, Tech. Coordinators. 1980. California wildlife and their habitats: western Sierra Nevada. Gen. Tech. Rep. PSW-37, Pacific Southwest Forest and Range Exp. Stn. Forest Serv., U.S. Dep. Agric. Berkeley, Calif. 439 pp.

Yeager, L.E. 1950 Implications of some harvest and habitat factors on pine marten management. Transactions North American Wildlife Conference 15: 319-334.

9.0 Appendices

9.1 Review of General Literature on Research and Enhancement for Upland Furbearers

9.1.1 Research priorities for furbearers

Furbearers have been identified for research due to several factors. These factors include an increased public awareness of non-ungulate game and non-game species, and an increased interest in the protection and management of these species. There is also concern about how intensive forest management or any large-scale habitat changes will affect these species and knowledge of habitat requirements of these species is very limited (Sadoway, 1986).

In Sadoway's (1986) problem analysis on the habitat requirements and effects of intensive forest management on the non-ungulate wildlife of Vancouver Island, the author concluded that simple basic information was lacking on many non-ungulate species. Knowledge of where species occur is important for ecological research of site selection and hypotheses testing of habitat values. Non-ungulate species that were rated high for research included species that had a low quality and quantity of information on habitat requirements and how these species were effected by change through intensive logging.

In a related document (Blood 1988) the objective of the study was to identify and rank furbearer management problems and research needs in B.C. The four highest priority management problems for furbearers were all habitat issues related to the forest industry (Blood 1988). These issues included:

1) lack of integration of furbearer and forest management,
2) effects of forest harvesting,
3) effects of herbicides, and
4) effects of other silvicultural practices on furbearers.

The highest priority species for research attention were suggested to be (from highest to lowest): marten, lynx, wolverine, fisher, beaver. Although there was some difficultly in tying specific furbearers to research topics (i.e. even though wolverine and fisher were identified as species for research, research topics did not score in the top 25), the four highest priority research topic-species combinations all involved marten and all involved habitat-related research primarily concerned with forest management. Specific research on marten included habitat selection/ requirements, effects of herbicides, and the effects of other silvicultural practices. The four highest priority research topics for lynx were the same as for marten (i.e. predominately forestry-related habitat research).

The two highest priority items for population research involving marten included: determination of population densities in representative habitats, and assessment of relationships between harvest pressure and age/sex composition of the catch. Lynx population research that was ranked included the determination of population levels in representative habitats.

Blood (1988) grouped the 25 highest priority species-research topic combinations into four potential research programs. The two highest potential research programs involving upland furbearers were:

Priority 1: Studies of habitat selection and use by marten and lynx in logged and unlogged area (possible secondary attention to wolverine and fisher).

Priority 2: Research on the population parameters of trapped and untrapped marten and lynx populations (possible secondary attention to wolverine and fisher).

9.1.2 Regional Wildlife Plan for the Omineca Sub-region

In the Regional Wildlife Plan for the Omineca Sub-region (Child and King 1988) forest management and timber harvesting are recognized as the most important issues affecting wildlife and are identified as a regional management issue. Although the authors indicate that logging can be beneficial to wildlife by the rejuvenation of forest succession, the impacts of logging are usually more detrimental than beneficial to wildlife. The following information is derived from their report.

Problems caused by current logging practices (usually clear-cutting) include increased access (and disturbance), loss of habitat and habitat diversity, removal of thermal and security cover, compression of habitat, loss of snags, reduction of food resources, reduction of coarse woody debris (or too much debris for a habitat to remain usable) and erosion of productive soil horizons. Additionally, clear-cut logging does not create a habitat mosaic typical of various seral stages required by many wildlife species. Child and King (1988) observed that habitat mosaics created by various selective cuts prior to the late 1960's. Clear-cut logging (post 1960's), with follow-up site treatment and reforestation have not proved to be a good substitute for the old logging methods or wildlife fires. Massive clear-cuts (created from combinations of logging, blow-down, disease or insect infestation) impact wildlife and habitat.

Child and King (1988) further point out that fire is a natural thinning agent and has exerted a profound effect, historically, on the maintenance of a mix of white spruce and balsam fir in the sub-boreal forest. Fire has created diverse habitats, maintained a mosaic of vegetative types and fire suppression has permitted habitats to become uniform and generally less productive for wildlife. Timber harvesting is not a substitute. It is also interesting to note that in studies in Alaska, marten will use areas that have been burned because snags or patches of snags and green trees left behind (See Section 9.2). This supports the above arguments that fires are an integral process in furbearer habitat.

Silvicultural activities, especially increased use of herbicides, are noted as affecting many wildlife species. Broadcast applications of deciduous suppressants destroy many shrubs and forbs important as food and cover for small mammals as well as large ungulates. Site preparation techniques (ie. burning destroys coarse woody debris [CWD]) can also impact components of furbearer habitat.

Specific to the Williston Lake watershed, many areas that have previously been untouched (i.e. south of the Peace Arm or north of Finlay Arm) will soon (if not already) be accessed for timber harvesting. Logging is now spreading into mid and high elevation forests which will impact furbearers as mature forest stands are removed.

Aside from forestry issues, increased access was indicated as a problem because of additional disturbance beyond logging activities. Also development of remote sites (i.e. mineral exploration) could cause disruption of behavioral and foraging patterns for some species such as wolverine.

Child and King (1988) conclude that harvesting methods, silvicultural activities, and increased and improved access are placing increased pressure habitat and wildlife populations. Inventory information is virtually non-existent for furbearers and biophysical mapping is needed for most areas in the Omineca.

Specific research and management activities mentioned by Child and King (1988) included:

A) Development of habitat protection/enhancement guidelines for those species with narrow habitat requirements.
B) Promotion and support of furbearer research, where possible. Topics of particular interest are:
  1. effects of habitat alteration on furbearer populations,
  2. impacts of different harvest strategies on furbearer populations, and
  3. development of inventory techniques for Class 2 species.

For example, marten are affected greatly by logging activities and lynx face an erosion of habitat by logging and post-logging treatments (herbicide). Habitat guidelines need to be developed to ensure the protection of marten and lynx populations and for the possible identification of enhancement opportunities. Other high priority species included wolverine and fisher, while wolf, weasel and coyote were considered of moderate priority and fox was considered low priority.

In Deems and Pursley (1978) the major reason given for furbearers extirpation from North America was habitat destruction. Fisher, lynx, marten, wolf, and wolverine were the furbearers lost from many of their previous ranges.

Banner (1976) suggests that apart from a loss of habitat, most furbearer populations have not changed significantly since the inception of the reservoir. However, it appears that habitat impacts past the date of the report have further impacted the habitat and changed furbearer numbers through habitat loss. Banner (1976) notes that a better information base on furbearers should be obtained and that trappers are the best source of that information. He also points out that all trappers must trap their lines to maintain a healthy trapping industry and that trappers failing to utilize their areas for two years in a row should have them redistributed to other trappers.

Kelly (1977) stated that current management had not been biologically oriented at the time of publication, but future management must if the fur resource is to remain an integral part of British Columbia's faunal heritage. He thought that furbearers faced two problems in the future: land alienation and increased trapping interest. He suggested developing appropriate guidelines be developed based on the individual species' ecological requirements and impact studies carried out in environmentally parallel communities. The obvious demands for such site-specific information should be sufficient enough to justify the commencement of comprehensive research. His report ends with pointing out that research on furbearers is essential to ensure not only continued propagation of the species but guarantee that recreational trapping will remain an important social benefit for residents of the province.

9.1.3 Biodiversity

From a biodiversity viewpoint, furbearers are an important and integral part of ecosystems. Biodiversity at the stand level is influenced by composition and structure of the stand. In British Columbia there is considerable uncertainty whether managed second growth stands will be able to offer the critical elements contributed by old-growth stands (B.C. Ministry of Environment, 1989). Some researchers have focused efforts on developing certain old growth characteristics in younger aged stands. In coastal forests in B.C., researchers have suggested that characteristics important for deer *(Odocoileus spp.)* winter range in old growth forests can be recreated in younger stands by the application of standard techniques (site preparation, regeneration, and stand tending) or specially designed silvicultural practices (Nyberg, *et al.* 1986). Some research efforts in this direction could be applied towards furbearers.

Harestad (1992) noted that furbearers are an important group of mammals that should be included in biodiversity studies. He notes that most furbearers are forest dwelling or forest associated species that have large home ranges and are more sensitive to landscape changes in their environment than are small mammalian herbivores that can live within a small patch of habitat. This agrees with the view that biodiversity is distinct from actual diversity of component parts. For example, while the diversity of generalist species in a recently disturbed site may increase temporarily, the value placed on the site's biodiversity may be decreased due to the loss of former habitat specialists (Balke *et al.* 1992). Furbearers are part of the biodiversity focus and, although researching furbearers and their habitat relationships are valid reasons for study, it must be noted that they are part of an ecological system. Management decisions should not be based on simple or superficial measures of biodiversity but instead on detailed knowledge of the species' ecology and behaviour. This can only be obtained by intensive in-depth studies of local populations (Davis 1992).

Hatler (1991) points out that many prey species of furbearers prominent members of forest ecosystems from both wildlife and forestry management perspectives. In the context of biodiversity, each furbearer has its own particular value and many play important roles in forest establishment (i.e. agents of spore and seedling dispersal, predators on insect pests). Occasionally furbearers cause harm to seedlings or small trees.

9.1.4 Wildlife Forest Management

In a literature review involving wildlife and forest management by Martelle (1990), the author notes that forest management activities have significant impacts on the habitat conditions of many wildlife species and that habitat conditions are prime determinants of the wildlife abundance in an area. In the past, when wildlife areas have been destroyed by logging, such occurrences have not usually been the result of forest policy but due to a lack of integrated resource management (Telfer 1974 cited by Martelle 1990).

Martelle (1990) further states that full integration of wildlife and timber in a managed forest requires specific, quantitative goals for wildlife values and goals must be translated into habitat conditions that can be affected by silvicultural and harvesting practices. Integration combines the diversity of species (flora and fauna) with fibre production, and entails the perpetuation of sufficient kinds, amounts, and locations of all habitats needed for the survival and reproductive success of all species in an area. The basic goal is to maintain species diversity through the minimum amount of habitat standards and to gain efficiency in meeting the multiple-resource goals for an area. Habitat conditions that enhance forest productivity should be favoured (Maser and Trappe 1984 cited in Martelle 1990).

To achieve a diverse wildlife population requires a planning approach that ensures a diverse environment. A management plan geared to provide this diversity would have as its goal not a given number of species but a given number of hectares of quality habitat would support a variety of species (Siderits and Radtke 1977 cited by Martelle 1990). Creating a forest with many varied communities and successional stages provides a diverse habitat structure and could provide adequate habitat for the majority of species in an area.

Timber harvest and silviculture practices, if correctly planned and executed, are the only practical, broad-scale tools that wildlife managers have for manipulating forest vegetation in a forested ecosystem to achieve wildlife goals (Martelle 1990). Habitat management practices can be used to produce or ensure continued forest diversity and an interspersion of different vegetative species, ages, and habitats. To achieve these goals, there must be a high degree of management coordination between planning and implementing forestry and wildlife objectives.

9.1.5 Specific Forestry Research Topics

9.1.5.1 Herbicides

There is more specific documentation for requirements into furbearer research and forestry impacts. In a problem analysis to assess research requirements to determine the effects of silvicultural herbicides on wildlife habitat (Biggs and Walmesley 1988), the problem analysis addresses the chemical, or herbicide options, because silvicultural herbicides have the potential for reducing available wildlife food sources and significantly altering wildlife habitats. As results, additional information on how herbicides affect wildlife habitats is required to assist forest and wildlife managers in providing a range of habitats for various wildlife species, while meeting provincial silvicultural policy goals (Biggs and Walmesley 1988).

Of the six integrated wildlife/forestry topics identified for research, the assessment of impacts by silvicultural herbicide treatments on small mammals and furbearers in the Sub-Boreal Spruce Zone (SBS) ranked fourth in priority.

In a literature review, Biggs and Walmesley (1988) found, although there were some small mammal/herbicide impact studies, there were no assessments of impacts. In general, extant bird and mammalian studies demonstrated that all wildlife species respond to changes in habitat, and appear to have an ability to adapt to habitat alteration, at least in the short-term. A limited number of wildlife studies reveal that the temporary reduction of competing vegetation on a given site by herbicides or other vegetation techniques was tolerable by wildlife as long as there was an adjacent source of vegetation available to colonize the treatment area, and a diversity of habitats are maintained in the surrounding area. Morrison and Meslow (1983 cited in Biggs and Walmesley 1988) suggested that the initial impact of clear-cutting had a far greater influence on wildlife than did any follow-up treatment. Morrison and Meslow (1983) further suggested that the response of wildlife to the entire range of forest management practices (*i.e.* not only to a single treatment), be considered, to put the issue of silvicultural herbicide use in proper perspective (Biggs and Walmsley 1988).

Small mammals/furbearer research was considered a high priority by Biggs and Walmesley (1988) because it is a major concern to the B.C. Trappers Association, B.C. Wildlife Federation, and provincial wildlife and habitat resource managers. Research is required to assess the impact of conifer release and herbicide brushing and weeding programs on snowshoe hare and other small mammals important as prey species for furbearing mammals such as lynx, marten, coyote, fox, fisher, and wolf. The impact of herbicide-induced habitat changes on all furbearers should also be assessed. The authors also noted that small mammal/furbearer research in the SBS zone should be initiated because this biogeoclimatic zone is very important to the trapping industry.

Biggs and Walmesley (1988) report cooperative research to determine wildlife habitat impacts associated with other vegetation management practices is also necessary, as most forest vegetation management activities cause alterations to habitats at the early and mid seral stages of the rotation. Habitat impacts associated with the use and timing of two or more vegetation management practices applied in combination should also be determined through research. Information from these vegetation management techniques could be used to enhance wildlife habitats, thus meeting both regional wildlife objectives and silvicultural policy goals.

The authors stress the importance of LSR (local stepwise research). In LSR the importance of the various physical and biological components of habitat for individual species are determined first (possibly through the current B.C. Wildlife Habitat Handbooks program). Research is then conducted to determine how herbicides affect the biological and physical components of the habitat. The final is the analysis of short-term and long-term impacts of this habitat change on local, regional, and provincial animal populations.

Biggs and Walmsley (1988) stress a very important point that is often overlooked. There is a need for communications, extension, and technology transfer (education). This need was also identified by several of the forest and wildlife habitat resource managers in the study.

In a related document on monitoring methodology for assessing the impact of forest herbicide use on small mammal populations in B.C., Ritchie and Sullivan (1989), note herbicide use had increased fourfold between 1983 and 1985, and this increase is expected to continue (Von Schukmann 1986 cited in Ritchie and Sullivan 1989).

Herbicide use is directed at the early seral stages of forest succession. Several small mammal species (important prey for furbearers) use these seral stages for forage and cover. Literature reviewed on furbearers in Ritchie and Sullivan (1989), indicated that species such as marten, weasel, fisher, lynx, fox, and coyote were considered heavily dependent on small mammal populations that occur in these habitats (ie. lynx/hare cycle) while wolverines will utilize small mammals to a minor degree and wolves are more dependent on larger game such as ungulates. Habitat alteration resulting form herbicide application could result in changes to small mammal species abundance and diversity. Additionally, ungulates may also be impacted by loss of forage from herbicide use so wolves are also impacted.

Several studies have identified the need to monitor the impact of herbicide use on small mammal populations and the results are summarized in Ritchie and Sullivan (1989). Three criteria were used to target small mammal populations for monitoring:

1. occurrence throughout either the Sub-boreal Spruce (SBS) or Coastal Western Hemlock (CWH) biogeoclimatic zones,
2. use of habitats subject to broadcast herbicide treatment, and
3. occurrence in the furbearer diet.

For example, in the SBS, the red-backed vole *(Clethrionomys gapperi)* have been identified as a target species for monitoring. They are also an important food of marten. Snowshoe hares a very important food of lynx, has also been targeted as a species to monitored in the SBS.

Ritchie and Sullivan (1989) conclude that concerns about the impact of forest herbicides on small mammal populations can only be addressed through a field monitoring program with the final outcome being a more enlightened, and possibly more efficient use of herbicides in intensive forest management.

Under information and research needs listed by the authors, several of the categories lend themselves to identifying furbearer research topics. These include:

1) long-term studies of vegetation response to herbicide treatment in the target subzones is needed. Information is required on the responses of the overall vegetation community, and on subsequent succession.
2) examination of small mammal responses to reduced availability of plant products (and browse for hares) and its relationship with damage to crop trees should be examined.
3) investigation of impacts of herbicide treatment on habitat use by furbearers. Research is also needed to assess the impact of shifts in small mammal community composition on furbearer diet, which may occur following habitat alteration.
4) potential direct effects of herbicide ingestion on small mammals and the connection of these effects to higher trophic levels, such as furbearers, should be investigated.

9.1.5.2 Manual Brushing and Weeding

In a review of current knowledge and information needs on manual brushing for forest management (Hart and Comeau 1992) the authors note that with the increased commitment to improving survival and growth of young forests in British Columbia and the increased pressure to reduce herbicide use on forest land and to buffer strips, it is likely that the use of non-chemical alternatives of brushing will grow. Further research is required to document the effectiveness of single and multiple manual brushing treatments, especially in comparison to herbicide treatments, and to identify optimum times for treatment. Although wildlife needs are mentioned briefly (more as forage for large ungulates), research of this type may provide knowledge into alternative treatments that may not be as harmful to furbearer habitat as herbicide use appears to be.

9.1.5.3 Alternative Techniques

In Principles and Practices of New Forestry (Hopwood 1991), alternative systems of harvesting ('traditional' clear-cutting) and silvicultural techniques are discussed. This paper denotes an approach to forestry developed in response to a broadening of forest management objectives and an improved knowledge of forest ecosystems, many practices described compliment furbearer habitat development. These alternative techniques may help retain a greater biological diversity, maintain a long-term productivity and protect the ecological resilience of the landscapes which are managed for timber production (Hopwood 1991). For example, in a section on wildlife trees and snags (Hopwood 1991), the author extensively researched reasons for retaining snags (for both wildlife and forestry viewpoints) and points out that snags become downed logs which are either habitat for various wildlife species or play a variable role in forest nutrient cycles.

Innovative silviculture can do much to maintain wildlife habitats in managed forests. A continuum of canopy cover can be retained by using different silviculture systems and research could be focused on which system provides the appropriate distribution and amount of canopy cover for a species such as marten. These methods can vary in the amount of structural diversity that is provided at various times in the rotation and structural diversity can be manipulated through the quantity, distribution of overstory and edge tree retention (Hopwood 1991). These methods can also be used for enhancement of stands for furbearer habitat.

The value in mentioning new forestry techniques is that alternatives are provided for managing both furbearer habitat and timber. Many of the procedures suggested in Hopwood's (1991) could lend themselves to research and enhancement in integrating both forestry and furbearer objectives in timber management.

9.1.5.4 Fire Suppression

Kelsall *et al.* (1977) describe where fire suppression is particularly efficient and long-lasting, the natural mosaic can be lost unless other factors replace fire as a disturbance factor. Forests that are protected with optimum efficiency will proceed to a relatively sterile and homogeneous climax of conifers. Effects of fire in the boreal forest on furbearers depend on the species involved. Red squirrels are reduced where coniferous forests is severely burned and cannot reoccupy an area in large numbers until conifers are established again. Neither marten nor fisher do well immediately following fire although there is evidence that both species can thrive in late stages of succession, when conifers once more dominate the landscape. Most other furbearers probably benefit from fire. Hares find food sources more abundant shortly after fire and small carnivores, such as weasels benefit from the increased populations of prey species that almost always results when fire creates faster growth and a greater diversity of plant species. Hares have been found to come back in the second year (after fire) when brush cover develops.

In Kelsall *et al.* (1977) recent studies of post-fire succession in northwestern Ontario confirmed that burned stands regenerate to the same species that were dominant before the fire. This implies "that cycling by fire rather than succession is the basic mechanism in this forest". Aspen and birch can invade burns and establish themselves in greater densities than formerly if seed sources are nearby but eventually conifers will dominate however the process takes a long time.

Kelsall *et al.* (1977) conclude there seems to be no doubt that late successional forests with large trees provide more denning holes and better general habitat for both marten and fisher. Both species are virtually absent from recent burned and logged areas and the fisher does better in second growth than marten.

9.1.6 General

9.1.6.1 Habitat Monitoring and Research

In Verner and Boss (1980), the report is structured in such a way that information is aimed at effectively assisting land managers in assessing potential effects on animals of proposed habitat management activities and identifying management and enhancement opportunities for wildlife species. The authors have designed the report in such a way it allows managers to formulate and evaluate alternatives for land and resource management planning, with reference to wildlife species. The information gathered puts wildlife habitat needs into practicable terms, a need mentioned by several resource managers. This type of approach could be used to some extent by the WWCP.

In this process, Verner and Boss (1980) point out once the basic habitats and broad wildlife effects have been determined, the analysis needs to be refined based on such things as interspersion of habitat types, the presence or absence of special habitats, specific requirements of species for water, space, and cover, and a host of other factors beyond broad habitat needs that enter into determining habitat suitability for a particular species. Dependent on the special habitat requirements of species, the larger the area the more likely the area is to have greater variety and interspersion of habitat types and seral stages, and to include larger blocks of the various habitats and the greater the diversity of species. This is a more 'landscape" management type of approach.

The authors indicate that even if information about the species/habitat relationships is used, further research is required into how the species/habitat "matrix" relates to patch size of any habitat stage or whether or not it is likely to be used by a species. Home range size information is required as well as how many animals of a given size can occupy a patch of a given size. Additionally, relating habitat use and home range size to population size needs to be researched. The need to know actual population sizes is required to put the habitat use information to good use.

Thompson *et al.* (1989) stated that the responses of small mammals herbivores such as the snowshoe hare, red squirrel *(Tamiasciurus hudsonicus)* and flying squirrel *(Glaucomys sabrinus)* to timber harvesting are not well known. All of these species (and others) are preyed upon by small carnivores (furbearers) commonly found in boreal forest including marten, lynx, red fox, and ermine *(Mustela erminea Linnaeus)*. No studies document habitat use by these predatory species except for a few dealing the marten (although this has changes since this paper was published). Specifically, it was tested to determine if track counts could be used to examine stand age preferences of boreal mammals, which months had the highest track counts, and whether track counts could be used as an index to change in abundance of individual species among years.

The data suggests habitat preferences for some species but more intensive study is needed to describe all habitats of importance of the species reported here. Track counts indicated that marten use of stands up to 38 years after logging remained significantly lower than that seen in uncut sites and appears to be the only furbearing species with a clear preference for uncut forest. Hare and lynx appeared to preferred successional habitats approximately 20 years old in mixed forests. Open areas in uncut over-mature stands supported shrub species that hare utilize.

9.1.6.2 Population monitoring

In Golden (1987 and 1988) surveys of furbearer populations in Alaska were completed to determine the distribution and relative abundance of red foxes, marten, lynx, and snowshoe hares using aerial survey techniques. Several trends were observed. Red foxes, largely, used the lake flats and important habitat for marten seemed to be mature coniferous and coniferous-deciduous mixed forests and a large burn. Lynx were most concentrated in mid-successional forests where the habitat was diverse and hare tracks were most plentiful.

Golden (1987 and 1988) concludes that the sound management of furbearers depends upon continued development of monitoring techniques, and upon robust analysis of the status, habitat relationships, and human use of their populations. Suggestions included refining aerial survey techniques and analyses of furbearer populations: (a) under various vegetation, terrain, snow, and weather conditions, (b) within areas of different size, and (c) for trend sampling. The author recommends calculating population vital statistics (analyzing the ages, sexes reproductive history of harvested furbearers through carcass collect) and examining the relationships between habitat characteristics and relative furbearer abundance. It was also suggested to get trapper cooperation and assess furbearer harvest patterns.

9.2 Review of Existing Literature on Upland Furbearers by Species

9.2.1 Introduction

In a sense this is not a traditional literature review and in some cases, takes on the form of an annotated bibliography. However, because there are so many species covered in this report and so many possible avenues for further research and enhancement, some papers are discussed in more detail than is normally found.

Each review on each upland furbearer was divided into sections on habitat use, habitat impacts, general biology (including food habits, home ranges and populations, harvest information) management implications and research recommendations and where information was available, HSI models.

9.2.2 Marten

The available information on marten ecology is overwhelming. Marten are solitary carnivores that were historically abundant in North American mature and old-growth coniferous forest (Strickland and Douglas 1987, Clark *et al.* 1987). Marten have been associated with late-successional and old-growth forest across much of North America (Weckworth and Hawley, 1962, Koehler *et al.* 1975, Mech and Rogers 1977, Soutiere 1978, Steventon and Major 1982, Spencer *et al.* 1983, Synder and Bissonette 1987, Bissonette *et al.* 1989, Buskirk *et al.* 1989). Typically, marten populations have declined with the removal of forested habitat, increased human access and unrestricted trapping (Clark *et al.* 1987).

Habitat Use and Preferences

Numerous studies have documented that marten inhabit late successional forest communities and are most abundant in association with mature coniferous species. Bateman (1986) found that marten preferred old growth balsam fir - white birch and balsam fir-black spruce forests with dense overhead cover. In Ontario, marten are 2 to 3 times more abundant in undisturbed forests than clear-cut areas (Thompson 1982) and densities in clear-cut areas in Maine were one-third of those in partially cut and undisturbed forests (Soutiere 1979). Marten were observed or captured most often in conifer-dominated or mixed stands of coniferous and deciduous trees (Mech and Rogers, 1977).

Old-growth conifer forests provide martens with important habitat components including high percentage overstory canopy cover, snags, fallen logs, trees with exposed root systems and abundant understory (Clark *et al.* 1987). Old-growth forests often support abundant small mammal prey because of the lush shrub and forb vegetation and structural diversity of overstory. Overstory canopy provides martens with protection from potential predators (Clark *et al.* 1987). Old growth forests provide important microsites for martens including resting and denning sites in large live trees, snags and down wood (Buskirk 1984, Clark *et al.* 1987, Buskirk *et al.* 1989). Because little fat can be stored, martens need to select resting sites that will conserve body heat (Buskirk *et al.* 1988).

Kelly (1982) found climatic variations occurring between habitats. The immature forest was the climatically the severest habitat, with the mature forest being the least severe. Kelly (1982) suggested marten select overmature forest because of favourable climatic conditions, an abundance of preferred prey species, good foraging conditions, and the opportunity to develop a strong social structure.

Slough (1989) noted that transplanted marten showed an affinity for late seral or climax coniferous forests types, often using the mountain sides from valley bottom (600 m) to treeline (1,200 m). Burns were utilized by transients and marten utilized deadfall areas and unburned inclusions. All individuals were frequently found at the treeline in the burn and forested areas.

One of the most frequently quoted papers is Steventon and Major (1982) where habitat use of marten and movements of individual marten were examined in 1978 and 1979 on the same commercially clear-cut area studied by Soutiere (1979) whom provided baseline data on population dynamics, habitat preferences, and food habitats as affected by forest clear-cutting. The current study was to examine how marten used the available habitats within the clear-cut and how forestry practices may be altered to benefit marten. The authors found that clearcut avoidance was pronounced during the winter and clearcuts were underused in summer (in proportion to availability). Marten were less susceptible to capture during summer when food, especially fruits and berries, were relatively abundant and marten hunting was associated with uncut and partially cut stands. The authors also noted that the structure of slash from clearcutting may be different from that resulting in from natural tree mortality in an uncut forest. Resting site habitat included decaying stumps, fallen logs or tree crowns and paralleled any other use of such sites. Steventon and Major (1982) concluded that marten need uncut and partially cut stands to survive during winter although they may use clearcuts in winter. Marten densities should increase when the regenerating clear-cuts mature into forest and marten are again able to meet their requirements within a smaller area on a year-round basis.

Marten use of successional stages was researched by Koehler *et al.* (1990). The results of this study indicated that marten used older-aged stands when voles were present and marten didn't use younger-aged stands where, based on track counts, red squirrels were most active during the winter. This is consistent with reports of the importance of voles and low occurrence of red squirrels in the diet of marten (Koehler and Hornocker 1977, Soutiere 1979, Weckwerth and Hawley 1962). Presence of voles in the greater than 82-year-old stands and their absence in 43-year-old stands may influence the selection for older-aged stands and infrequent use of younger aged stands. Marten use of greater than ≥ 100-year-old Engelmann spruce/subalpine fir stands also coincides with sites where red squirrel middens were most abundant. Middens may serve as resting sites for marten and their presence may also influence the selection for older-aged successional stages by marten (Buskirk et al. 1989 cited in this report in Koehler et al. 1990). These observations show the importance of older aged stands as habitat for marten during winter. Although clear-cuts and early successional stands are utilized during snow free seasons marten require mature forest stands during winter where prey (Koehler) and rest sites (Buskirk *et al.* 1989) are available. For these reasons it is important to manage for mature and old growth stands as habitat for marten.

In Bissonette *et al.* (1989) the authors make a case for landscape-level management. To effectively present their position, the authors discuss habitat preference for marten. Marten prefer dense, mature coniferous forest or mixed forest with high overstory density (as already mentioned). Reasons are not clearly understood, but overhead cover from provides protection form predation, provides prey abundance and availability and meets thermoregulatory needs during winter (Buskirk *et al.* 1987). Large clear-cuts have been shown to be detrimental to marten populations in North America and Europe (Gravok 1972 in Bissonette *et al.* 1989). Even regenerating clear-cuts are used infrequently or avoided. In Wyoming, clear-cuts less than one year old were not used by marten (Clarke and Campbell 1977) and regenerating clear-cuts in Maine were only used in the late summer when berries were present. In areas of extensive clear-cutting in Newfoundland, Synder and Bissonette (1987) and Bissonette *et al.* (1988) found marten concentrated their activities in undisturbed forest. Throughout the study, marten were found in clearcuts in only 2.2% of the time and results of this study clearly indicate that marten require old growth habitat and that populations will decline as old-growth timber decreases.

Baker (1992) found marten use habitats that have high prey density such as mesic sites or mature coniferous forest with greater than 30% canopy cover and use riparian zones for foraging but move to nearby coniferous forests to rest. Baker (1992) suggests that the quality of marten habitat is related to the availability of habitat types that provide them with an abundant food supply. However, since Baker's study was conducted on Vancouver Island, which has a vastly different (less severe) climate that the Williston Lake watershed, her findings must be interpreted with caution. Densities of marten in the study area were lower than estimates from other regions of North America where timber harvesting had not been as extensive and the differences in densities from other studies suggests timber harvesting results in lower marten densities for a period of time after timber harvest. Baker (1992) found high use of second growth stands was likely due to the unique characteristics of coastal, first rotation, second growth forests. Frequent canopy openings, abundant understory and large diameter trees create suitable marten habitat at a much earlier seral stage than observed elsewhere in North America.

Flynn (1991) studied habitat use by martens during fall and winter in Alaska. Martens were found to select higher-volume old-growth forest types at low elevations (<240m) and selected more productive forest types, primarily western hemlock and western hemlock/Alaska cedar associations. Low-volume old-growth forests were used as available and nonforest types, including clearcuts, were not used.

Specific Habitat Characteristics

In a study on habitat characteristics at marten subnivean access sites (Corn and Raphael 1992) the authors found that the occurrence of coarse woody debris (CWD) at sites of subnivean access by marten had not yet been quantified adequately and must be better understood to provide suitable winter habitat. Martens use subnivean space to obtain rest sites and prey, both important components of winter survival. The authors studied subnivean activity by marten in a subalpine forest in southern Wyoming to discover how subnivean space was accessed and to examine microhabitat characteristics around entry sites. Existing openings in snow were created primarily by logs at low snow depths [downed logs, including single logs (37 cm avg. diameter) elevated by terrain and stacks of 2-4 logs] and by small (17 cm avg. diameter), live spruce and fir trees at greater snow depths. Subnivean entry had greater percent cover and total volume of CWD, greater numbers of log layers, greater volume of undecayed and moderately decayed logs, less volume of very decayed logs and fewer small root masses than surrounding forest stands. The authors indicated that the provision of sufficient CWD in winter habitat of martens may require specific effort and that access/use to subnivean sites is likely tied to the occurrence and abundance of CWD (snags, downed logs, large root masses) and has been documented by other studies. CWD is important because it provides breaks in the snow for access or assessment of prey availability and structural feature of subnivian space provide for rest and catching prey. Rest sites are reused in the winter and marten will dig through snow to get to them. When snow is too deep, marten use small trees are more commonly used to get to subnivean sites. The authors note that spruce and fir have large lower growing branches in contrast to larger trees and lodgepole pine and offer greater access to subnivean areas.

Similar findings for resting sites have been described. In Marten and Barrett (1991) the authors describe resting sites used by marten. Snags, stumps, logs, and tree canopy made up 74% of 155 marten resting sites. Resting sites in snags, stumps, and logs were selected by marten and live trees were avoided. Snags, stumps, and logs used for resting were significantly larger then those available and stumps were used more in the summer and snag and log dens were used more in winter. The authors note that preserving large snags and naturally occurring logs, and leaving cull logs and high stumps after timber harvest should benefit marten. The results of this study are consistent with Buskirk *et al.* (1989). They found marten in Wyoming used subnivean resting sites associated with coarse woody debris in the coldest weather in the winter, and postulated that these resting sites provided the greatest protection against energy loss and are discussed below.

In (Buskirk *et al.* 1989), the authors report similar findings to Corn and Rapheal (1992) where spruce-fir habitats are preferred over lodgepole pine. In summer, marten generally rest in above ground sites, often in the canopy layer but in winter, to offset thermal losses, 63.1% of resting episodes were in subnivean sites associated with CWD. The authors found that resting site use was characterized by proximity to surface water and the most important winter resting sites were in subnivean locations partially or entirely surrounded by CWD. Winter resting sites provided protection against likely predators (coyote and horned owls) and marten alternated resting sites in response to ambient temperature (i.e. juvenile marten were more likely to rest above the snow surface on warm days). Marten were not found resting in sites completely surrounded by snow.

Buskirk *et al.* (1989) noted that the preservation of spruce-fir stands (historically) near streams and aggregates of CWD are commonly found in steep-sloped, upper level riparian areas through the process of natural downhill movement of windthrow and earthflow. Prey availability is likely higher in riparian settings than elsewhere, either because prey densities are higher or because structural features, including CWD, make subnivean prey more accessible to marten. The energetic benefits would appear to accrue to marten from resting near foraging areas, especially during periods of severe cold and other studies have found marten attracted to riparian habitats.The authors suggested that juveniles used lodgepole stands for resting more because adults may exclude juveniles from preferred resting areas so juveniles are left with lodgepole stands with little CWD or juveniles may lack experience in choosing good resting sites.

Baker (1992) also noted that coarse woody debris is important to marten as denning, resting and hunting sites. Amounts of coarse woody debris in first rotation, coastal second growth forest stands tends to be high and may contribute to use of younger forest stands by marten in coastal ecosystems

In Magoun and Vernam (1990) the authors questioned the exclusivity of the generalization often made in the literature that marten restrict their use of large forest openings to summer. The authors found that burns had lots of debris and note that many researchers have come to recognize the importance of log debris and other forms of ground-level cover to marten habitat suitability and that the evaluation of log debris is important for marten habitat structure.

Koehler and Hornocker (1977) found in researching the effects of fire on marten habitat that marten passed through but did not hunt in openings less than 100m in width during the winter. Open meadows and burns, avoided by marten in the winter, may be used in the summer and fall seasons if they provide adequate food (The high occurrences of fruits, insects and ground squirrels the summer-fall diets of marten supports this). The authors conclude that fire is important in maintaining a diversity of forest communities by creating openings for food, spruce/subalpine fir forests are utilized in the winter and the mosaic effect of forest types can also be expected to result in smaller and generally cooler fires, which would result in less marten habitat being replaced through time and space.

Habitat Alterations/Impacts

Loss of large areas of old-growth coniferous habitat because of harvesting and fire, and excessive trapping of marten have been cited as major reasons for their decline in distribution and numbers in some parts of North America in the past (Koehler and Hornocker 1977, Mech and Rogers 1977). Marten had a wide distribution in most forested regions of Newfoundland, however, they are now restricted to isolated areas of mature forest in the western part of the province (Synder and Bissonette 1987). Thompson (1988) found that marten prefer old growth forests and that marten populations in logged areas were about 10% of those in uncut forest (up 40 years after logging). Yeager (1950) noted that there high populations of marten due to the remoteness of ranges that extensive lumbering could offer serious limitations to martens (from a food standpoint). Yeager (1950) also found that marten used dead stands (either destroyed by fire or bark beetle infestations) since marten foods (small mammals and birds) were slightly increased in these areas. Martens have been significantly reduced over the last 100+ years by extensive habitat alteration and over exploitation and have been completely extirpated in some portions of their range (Clark *et al.* 1989).

Flynn (1991) cites several studies documenting the negative impacts of logging on marten populations. These negative impacts include the removal of overstory cover, the loss of coarse woody debris (standing snags and down wood) reductions in prey abundance and hunting efficiency, greater habitat fragmentation, and increased human access. In particular, clearcutting old-growth forest removes all of the forest canopy and standing dead wood which have been found to be important components of marten habitat. As clear-cut stands begin to generate in southeast Alaska, the overstory canopy closes after 15-52 years, smothering understory forbs and shrubs which provide important habitat for small mammalian prey. Eventually, the large down wood in the regenerating stand decays and disappears further reducing the habitat value for martens and small mammal prey. In addition to stand-level effects to habitats, forest management has landscape-level effects such as road construction into previously roadless areas and habitat fragmentation (Bissonette *et al.* 1989 cited in Flynn 1991). Logging roads greatly increase trapper access to martens: this can result in over exploitation. As previously mentioned Bissonette et al. (1989) recognized the need for landscape-level management for martens including the maintenance of large habitat patches and movement corridors.

In Kelly (1982) forest harvesting was considered to have eliminated marten use of preferred habitats during winter. A more severe climatic, bioenergetic imbalance, loss of prey, disruption of social structure resulting in increased intraspecific competition were attributed to logging.

In Archibald and Jessup (1984), the authors describe the present distribution of marten in North America as considerably smaller than its known historical distribution and that the decline in marten distribution has been attributed to the destruction of mature coniferous forests by fire and logging and to trapping. The upward trend in marten harvests and the growing potential for habitat destruction through logging, road building, and mining and hydro development clearly demonstrated the need for a population and habitat management strategy for this species.

A study in western Newfoundland (Synder and Bissonette 1987), designed to determine if marten use was influenced by stage of regenerating forests in clear-cuts and size of residual stages, found that 23 years after timber harvesting was still insufficient time, in this area, to provide adequate marten habitat. However, this may not be true elsewhere where growth is more rapid and different cover species occur. Overhead cover, small mammal availability and abundance, and resting and denning sites are critical factors for marten and these appear to be lacking in the regenerating clearcuts. Residual stands and areas of undisturbed forest can provide these important habitat components and enable at least a remnant marten population to survive despite clear-cutting. If large clear-cuttings continue to be the predominate method of forest harvesting (contiguous cutting year-after year), available habitat/populations will continue to decline. More intensive study of marten use of clear-cuts in required to document the stage of regeneration that will provide adequate habitat for marten.

Synder and Bissonette (1987) mention that marten may have taken advantage of temporary prey increases in abundance in the 'newer' clear cuts but decreased as clearcuts grew over 2m high (possibly because due to dense vegetation decreasing marten hunting success by increasing escape cover for prey). Although prey abundance may not be affected by forest harvesting, availability may be decreased especially during winter (Koehler and Hornecker, 1977). These authors also believed that the dense growth of vegetation in clearcuts may have inhibited visual contact with prey and provided escape cove for small mammals. In Thompson and Colgan (1987), the authors observed during a 4-year investigation into the effects of timber harvesting on martens, a local decline in prey populations of marten and described numerical responses of martens to reduced food. In a more recent paper Thompson and Colgan (1990) describe marten as hunting by searching under logs, stumps, rocks and crevices and holes in the snow which indicates some need for CWD. This hunting strategy that ensures some food is captured regardless of size between less frequent kills of large prey.

In Loforth and Steventon (1990) the authors cite studies that suggest that leaving 40-50% of the canopy and leaving at least 40% of the trees didn't alter conditions enough to influence the preferred small mammal foods of marten. To what extent clearcuts recover as suitable habitat (15-40 years cited) is dependent on ecological site conditions and on silvicultural treatments applied. The authors note that burns are utilized more quickly than clear-cuts possibly because of large amounts of CWD being left behind and patches of unburned trees.

In Brainerd (1990) the author describes marten as both a 'food generalist and a habitat specialist' and notes that habitat interspersion is important. Marten prefer old growth and mesic spruce sites not pine. Brainerd (1990) describes the distribution of food items as an important influence in marten habitat selection and suggests that marten may be suspectable from attack by avian predators (due to dark coloration) and may be exposed to attack from fox and lynx in areas without tree cover normally used by marten as escape cover.
The author agrees with other studies that marten generally avoid use of clear-cuts except during late summer when there is greater seasonal availability of raspberries and ground nesting birds.

General Biology

Food Habits

As for habitat use, marten food habits have been described by many authors. Baker (1992) found the major prey groups (by scat analysis) were berries and small mammals. Minor prey groups were insects, birds and ungulates. Food habits varied seasonally and in winter, small mammals and ungulates were highest on diet and in summer, small mammals, berries and insects were dominant and during summer, berries and insects were dominant.

Marten consume a wide variety of food items throughout the year with mammals being the most important most important food item on an annual basis, with the highest utilization of mammalian prey during the winter months (Allen 1982). Voles are utilized more than any other single food item (Weckworth and Hawley 1962, Koehler and Hornocker 1977, Soutiere 1979). Berries are eaten in the summer and invertebrates and passerine birds are also found.

Kelly (1982) found the red-backed vole was the predominant food item (72.9%) and a decline in the vole population coincided with a decline in the frequency of use of red-backed voles. Deer mice *(Peromyscus maniculatus)* were the second most important food item (21.4%) filling the void created by the decline in red-backed vole populations. Red squirrel was the third most important food item. Kelly (1982) found that prey habitat selection coincided with marten habitat selection. Red-backed vole was more abundant where ground conditions were mesic and deer mice significantly more abundant on xeric sites. Kelly (1982) points out that loss of cover through logging completely changes the environment through changes in microclimate, change of prey, change of social structure and so forth. The timing of logging activity is also important. Winter logging is the most detrimental as it occurs during the marten's most vulnerable period. During summer, some shifting and accommodation can occur, however in winter the preferred habitat is occupied.

Clark and Campbell (1977 cited in Kelly 1982), followed a small mammal population during a term of logging. Red backed voles were the most common species on the undisturbed mesic sites and disturbed xeric sites showed a significant change in species composition. Preharvest data showed a population composed principally (73%) of voles. This changed predominantly to a deer mouse population (80%) six months after logging.

In Allen (1982), Mech and Rogers (1977) reported that food availability is probably the most important factor affecting the distribution of marten. Fluctuations in small mammal densities in Montana were believed to directly affect the carrying capacity of an area for marten. Limited access routes to prey below deep snow may be more restrictive on marten winter densities than actual densities of rodents present.

In Lensink *et al.* (1955), the food habits of marten were found to be intimately associated with its movements and other factors related to its distribution and abundance. The trapping of marten was inversely proportional to the availability of food, since marten movements are greatest when food is least available. Microtines were the most important food, comprising 74% of diet in summer and 68% in winter. The authors conclude that changes in abundance or availability of food may be reflected strongly in the marten's movements, its productivity, and its choice of habitat.

In Quick (1955), an analysis of marten food habits was made to evaluate the relationship of this mammal to the carrying capacity of its food base. Quick (1955) found that marten are able to adapt to drastic changes in prey population levels by shifting to more available or more vulnerable species. The author listed the important food base complex during the most critical period of the year as consisting of red-backed voles, deer mice, red squirrels and snowshoe hares.

In Weckwerth and Hawley (1962), adult females and juveniles were found to have suffered greater mortality in initial population decline when the prey base decreased possibly because of the greater food requirements of juveniles for grow and adult females for production and care of young. Mammals were by far the most frequent and stable item in the diet. During the summer periods when other foods, especially berries were abundant and became prominent in the diet, and it appeared that slight fluctuations in the frequency of occurrence of mammals were more affiliated with high availability and consumption of other foods than with the fluctuations in abundance or availabilities of the mammals. Clerionomys was the staple food of marten (as shown by other studies in North America) and weasel is an unusual food of marten. The authors summarized factors affecting use of a particular marten food source as:

1) availability
2) preference
3) availability of other food items

Thompson and Colgan (1990) found variation in diet choice by marten among seasons and between sexes and ages. Marten were found to be 'catholic' in the selection of prey and made use of available mammalian prey, ruffed grouse, passerine birds, berries and insects. Diet niche was widest during low prey abundances (i.e. winter) and the proportion of small prey species in diet was correlated with absolute abundance, but proportion of some large prey was related to their relative abundance. Diet choice varied by season and among years with berries and insects being common in summer months while large, particularly the varying hare were more frequent in the summer diet. The authors suggest that marten primarily forage for large prey but employ a strategy that results in encounters with small prey as well and provide energy at minimal cost between captures of large prey.

Fudge *et al.* (1989) state that regular fluctuations of small mammal populations are a common occurrence in northern ecosystems. Intrinsic factors, such as those associated with behaviour and genetics, seem to be the most important factors causing a decline in small mammals. Small mammal population fluctuations, at least those involving microtone rodents, are characteristically synchronous over large animals.

In an interesting sideline, Henry et al. (1990) researched prey caching in marten since "prey caching has important implications for foraging frequency and energetics of marten". The conclusion was that there is no evidence that marten were involved in surplus killing and hoarding like other mustelids (ie. stoats) but it's possible there may be minor hoarding during winter.

Home ranges and Populations

Lofroth and Steventon (1990) cite home ranges reported in the literature as ranging from 0.8 km^2 to 8.4 km^2 for adult females and 2.0 km^2 to 15.72 km^2 for adult males and male home ranges are typically twice the size of female home ranges.

Clark *et al.* (1989) found that home range spatial overlap was extensive within and between sexes but male ranges overlapped little temporarily. Martens showed spatial use patterns similar found for martens elsewhere and the author recommends that widely spaced traps that exceed the diameter of female home ranges would selectively take more male and protect females. The conclusion is marten space use is affected by a complex array of environmental and social factors including food.

Kelly (1982) suggests that more important than having adequate area for one optimal home range, is the need to have adequate contiguous preferred habitat for a population to succeed. In good habitat marten require 0.5 km^2 to 2.0 km^2 per home range and the inclusion of transients and temporary residents reduce the density (dependent on prey availability). Assuming 500 km^2 is a minimum then an area of no less than 750 km^2 of preferred habitat is required. Since preferred areas are normally not in neat compact parcels of land, then areas of 900 to 1000 km^2 are required (eg. a whole watershed).

Harvest

In Yeager (1950) harvest patterns are discussed including males are mostly caught by trappers regardless of the season and that fall trapping results in higher number of males than winter trapping. There may possibly more females trapped later in the season and less males, due to less prey available (scarcity)/and or nutritional costs rising due to pregnancy. Also males range further and females may be more secluded cause of pregnancy. Birth rates of males/females appear equal.

If adequate prey is not available or adequate means to reach prey (i.e. coarse woody debris) females marten and fishers may be forced to roam further in search of prey (trappers, pers. comm.).

Archibald and Jessup (1984) noted that there was a higher proportion of male population was trapped as per Yeager(1950) and de Vos (1952). There is an assumption that the sex ratio of marten in the wild 1:1 and an exhaustive harvesting program (removing all marten) would produce 1:1 sex ratio.

Fudge *et al.* (1989) found that furbearer management in Labrador is reactive because of the system of competitive trapping making it difficult to manage harvest levels . Since there was a decline in small mammal numbers and more females than males were being trapped with a low proportion of juveniles to adult females, the authors expected the marten population in Labrador is about to decline.

In Buskirk and McDonald (1989), the authors suggest that site specific home range sizes may be an indicator of habitat conditions and suggest a need to show a functional relationship between home-range size and resource abundance. This is important to managers for deciding how much conifer dominated forest required by marten needs to be retained when many stands are shifted to early successional stages.

Management Implications and Research Recommendations

Kelly (1982) suggests short-term management to minimize the impact of habitat changes during critical periods of the year. Options such as the felling of trees during non-winter periods, provides the marten a chance to re-establish home ranges and social status while food supplies are most abundant. There should be no felling during whelping period between April and June when the young and mother require an assured food supply and shelter. The restriction could be limited to overmature white-spruce -subalpine fir forests. Kelly (1982) also suggested cooperative trapping and felling where a trapper should trap area just prior to logging to prevent additional impact of population displacement on adjacent marten populations. Suspension of trapping in a band 2km wide around the logged area until the following trapping season would allow the remaining marten a chance to re-establish territories.

Kelly (1982) suggests long-term considerations to ensure the survival of the species as a whole, and specifically on ecologically divergent units (watersheds). Recommendations range from establishing wildlife reserves on marginal forests to preserve marten habitat to the exclusion of selected high quality (for marten) watersheds from the annual allowable cut to ensure population reservoirs throughout the province. Additionally limiting clearcut openings to a maximum 10 ha and the total area logged within a contained unit not to exceed 40% of merchantable timber. Clearcuts should have a minimum buffer of 1 km of preferred marten habitat adjacent. In prime habitat, selective logging is encouraged by either tree species or diameter limitation. Total clearing should not to exceed 40% of the total merchantable timber and unlogged areas to be left at least 50 years.

In Baker (1992) management recommendations were based on home range and habitat use by marten as functions of:

1) distribution and availability of prey
2) availability of suitable den sites

The high use of second growth forests by marten on Vancouver Island suggests that younger seral stages are used when conditions within the stands are adequate for denning and hunting. CWD (large diameter stumps, debris piles with piece size >50 cm in diameter) were present as natural den sites created from windthrown trees. Areas which had frequent canopy openings, dense understory shrubs, and herbaceous vegetation and abundant coarse woody debris were important for hunting. Suitable denning, resting and hunting sites are important structural attributes which should be maintained or created in forest harvesting plans. Large diameter stumps should be left as intact as possible and debris could be left or at least lightly burned. Intense broadcast burns should be discouraged in an attempt to maintain overhead cover for marten and protection from avian predators in newly logged blocks. Buffer strips or travel corridors between cut blocks could be planned to allow for security and thermal cover close to cutovers and non-uniformly stocked stands are desirable to provide a mosaic of canopy openings and trees. Blocking of logging roads which are no longer required for timber harvesting or silvicultural activities could be used to reduce access.

As with other authors, Baker (1992) considers trapper management as important. For example informing trappers of the need to retain unharvested source of marten within their traplines as refugia is an important management tool.

Bissonette *et al.* (1989) discuss whether marten used residual stands isolated from continuous old growth forest, and if so, were there identifiable characteristics would allow prediction of their use. The authors point out that marten prefer residual forest over clear-cut and regenerating areas, and will use patches of residual forests if greater than 15 ha. Recommendations include changing logging operations from large-scale clear-cuts to much smaller-scale patch cuts since the results clearly indicate that marten require old-growth habitat and that populations will decline as old growth is cut.

Bissonette *et al.* (1989) suggest orchestrating woods operations in such a manner as to allow an economic harvest while yet providing for the continued existence of threatened marten and the other species dependent on large expanses of old-growth. Dead timber is only commercially useable for only 2-3 years after defoliation. Landscapes have been defined as heterogeneous land areas composed of a cluster of interacting ecosystems, or landscape elements occurring repeated across

the landscape. Patches, corridors, and the background matrix of vegetation are the units of interest and measure. Management across a large landscape eliminates the need to protect any one stand in perpetuity, rather, the landscape elements are managed to maintain a shifting mosaic with predetermined proportions of each habitat element
Marten sensitive to patch size (Synder and Bissonette 1987) and need a certain amount of core (diversity of other species also correlates closely to patch size. Patches that tend towards minimum perimeter length isodiametric shapes, maximize interior area and minimize edge
Data indicates that marten populations are greater in undisturbed forest with a large core area (15 ha or greater).

Thompson and Colgan (1987) believed that a reservoir strategy for marten management is an effective tool. Given that marten are so easily trapped and have reduced populations in logged areas, untrapped, uncut reservoirs are the most likely reason that the animals have survived over much of their present range. In other areas, where few or no reservoirs existed, marten have become extinct or severely reduced in numbers (Bergerud 1969, Dodds and Martell 1971, Mech and Rogers 1976) When coupled with the reservoir strategy the manager must maintain the flexibility to apply quotas or curtail trapping in periods of low food resources. The authors suggest that managers annually calculate age ratios of the martens caught as well as develop indices to relate population sizes to food availability, habitat etc.

In Clark *et al.* (1989), the authors suggest that understanding local and regional marten population characteristics is fundamental to sound management. The data presented here, combined with cited data, can be used to model the effects of systematic habitat changes (eg logging) and stochastic events (eg. diseases) on small marten populations. Such a viability can estimate extinction probabilities of marten populations of various demographics. Viability assessment, determination of area requirements, and careful habitat management are essential for conservation of this important forest carnivore and indicator species on national forests in the Greater Yellowstone Ecosystem.

Archibald and Jessup (1984) point out that the population growth rate is the highest among unharvested populations. These results suggest a management strategy of setting aside blocks of land as reservoirs from which dispersing marten would be harvested. Size and configuration would be dictated by local physiographic conditions. Trapping trails through or around the perimeter of reservoir must be no less than 3 martin ranges apart to preserve a resident population. These studies suggest that traplines need to be 10Km apart.

Archibald and Jessup make the following points:

1. Harvest should be exhaustive along trails as it is highly unlikely that marten will move into unoccupied territory during the winter. Also, by creating an area totally devoid of marten, habitat is provided for dispersing marten the following summer (age structure?).
2. Integrity of reservoir must be maintained. If marten suddenly decrease, then reduce trapping pressure on the population.

Brainerd (1990) reviewed management recommendations in other studies. Snyder (1984:in Strickland

and Douglas 1987) recommended to foresters that isolated blocks should not exceed 250m with uncut strips 0.1km wide along waterways to allow communication between patches. In Maine, Soutiere (1979) proposed that clearcutting should be done in small blocks or patches and that at least 25% of the remaining area be retained in forest cover of at least 25m^2/ha of pole stage and larger trees. In their review, Clarke *et al.* (1987) state that continuous optimum habitats of 150 km2 should be connected to smaller habitat patches of at least marginal habitat. They further state that clearcutting should be minimized and be replaced with selective logging to maintain canopy coverage and mesic conditions. Dead standing and leaning trees and snags, and woody debris associated with logging should also be preserved for foraging, resting, and denning. Also smaller clearcuts create a heterogeneous mosaic by increasing edge and thus improving foraging.

In Corn and Raphael (1992) conclude that forests are fire dependent with lodgepole pine invading after fires and spruce-fir forests coming in as climax community on mesic sites. CWD accumulations in managed second-growth stands are lower than that found on natural stands (because stand management typically removes logging debris) and CWD requires specific management efforts.

In Buskirk *et al.* 1987, woody debris is considered a characteristic of old growth forest. Spruce-fir stands are important because of the CWD and their retention and dispersion has importance for management.

Loforth and Steventon (1990) summarize their findings into specific management recommendations. Suggestions include partial or selective cutting systems that can effectively maintain marten habitat values are a preferred harvesting method. The authors note that cuts which reduced basal areas by 40% leaving residual stands of 20-25m^2/ha didn't change marten densities and suggest guidelines include leaving about 50% of the basal area or minimum of 20km^2/ha basal area and a minimum of 30% canopy.

Loforth and Steventon (1990) recommend to maintain at least minimum population numbers, at least 50% of an area must remain as marten habitat. Population refuge areas along traplines should be established if possible. To provide CWD, logs, stumps etc. should be left behind and the authors recommend (based on other studies that showed marten had preferences for areas with 125-200 logs/ha, snags at 3-6m^2 basal area/ha and 50 -75 stumps /ha) at least 100m/ha of logs >20 cm be left and 5m^2/ha basal area of snags. Site preparation should avoid creating clean sites (no high intensity burns, stump removal etc.) and excessive brushing and weeding should be avoided since it reduces prey populations and berry crops that marten utilize in late summer.

Habitat Suitability Index Models

Habitat suitability models are a means of quantifying habitat quality and provide an objective tool for assessing the impact of forest management plans and transferring information (Banci 1989). There have been several designed for marten including a working plan for HSI marten research in the Sub-Boreal Spruce sone (Lofroth and Banci 1991).

Schultz and Joyce (1992) chose marten to test the spatial application of a marten habitat model because of its designation as an indicator species by several National Forests within the Rocky Mountains.

The authors investigated the implications of a spatial application of a marten habitat model and changing grain (sample unit) size by assessing the amount of habitat within potential home ranges. The size and spatial distribution of habitat patches, as well as the total amount of habitat, influenced the degree to which changing grain size modified wildlife habitat estimations and the authors concluded that models need to incorporate spatial aspects of habitats that recognize juxtaposition as well as amount of habitat. The results of this study indicated that species responding to changes occurring below the grain of the available data may not be accurately modelled. For example, even though 30m (grain size) is more than adequate for marten modelling, it is only 25% of a Southern red-backed vole's (the marten's main prey) home range. Additionally, grain size must be sensitive to special habitat requirements and intended use and as well as home range (small rare patches may be lost with larger grain size).

In Magoun (1991), the author states that habitat suitability models were developed to predict the capability of an area to support a particular wildlife species based on a number of habitat variables. Models have been developed for other areas but none for interior Alaska and understanding the attributes of burns that make it attractive to marten is essential to the development of marten hsi models for interior Alaska. The ultimate objective is to arrive at habitat variables and suitability indices that are not only applicable over a range of successional stages, but also are based on a sound understanding of marten ecology.

Existing marten HSI models use standard forest inventory data such as average overstory tree size, percent canopy closure, log density in tons per acre and forest cover type as habitat variables and this allows forest management recommendations to be couched in forest industry terms.

9.2.3 Fisher

There was a lack of literature for fisher so most of the information for fisher was derived from Banci (1989) where the author focused on the management of fisher populations and their habitats in British Columbia. The author also completed a review of the literature (and composed an annotated bibliography). Other literature obtained was added to this review.

Habitat Use and Preference

In Douglas and Strickland (1987), fisher are described as being found in mixed forests with a diversity of tree sizes and ages. The availability of food appears to be the most important factor governing habitat selection. Overhead cover and denning sites are important and maternal dens are generally found in large deciduous trees. Fisher also use temporary shelters such as hollow logs, and tree cavities, brushpiles, rockpiles, burrows and dens of other animals and snow dens.

In Banci (1989), the author notes that fishers utilize ecotones and edges, the transition ares between different habitat types and riparian areas and that fishers are not as dependent on climax coniferous forests marten are. Fisher generally occur at the middle range of elevations and changes in elevations between seasons do not occur. Descriptions of habitat use of fishers and quantitive studies are biased to habitats in eastern North America and a high degree of diversity and interspersion appears to be critical habitat needs for fishers.

Several studies have identified the use of edges or ecotones by fishers and the importance of these habitats may be seasonal. In New Hampshire, edges were used in proportion to availability during winter, but more than availability in summer (Kelly 1977). The importance of riparian and wetland associated areas has been documented by studies including (Raine 1981 and Kelly 1977).

Forest cover was found to be important and several researchers have documented that fishers avoid habitats lacking overhead cover. However clearcuts were important areas for foraging in summer even though clearcuts were avoided in the winter. Monotypic (uniform) forests providing year-round cover were rarely used probably because of the lack of structural diversity and low prey density (Johnson 1984 cited in Band 1989).

From the literature reviewed, Banci (1989) describes the 'best' habitats for fishers as multi-aged stands interspersed with openings and containing wetland or riparian habitats. The author describes dens used as resting sites by fishers as diverse and include snow dens, hollow logs, and holes in the ground, witches brooms, squirrel nests and raptor nests. Natal dens almost exclusively occur in cavities in large dead trees, located 7-12m above the ground. Tree cavities provide thermal protection for kits, protection from adult male fishers and security from predators.

Banci (1989) reports that reserves of logged and untrapped wilderness have been important in the re-establishment of fisher populations. Such reserves not only provide a source of dispersing fishers for trapped regions but are insurance against population reductions. Trappers may be able to maintain adequately sized reserves on their traplines but size of this area will depend on habitat quality.

In Arthur *et al.* (1989), the authors studied habitat use and diets of fishers in south-central Maine. The authors found that coniferous stands were preferred for rest sites during spring, summer, and fall when fishers usually rested in the branches of coniferous trees (usually surrounded by other conifer trees). Fishers did not need large blocks of coniferous tree and during winter, and usually rested in ground burrows in mixed deciduous-coniferous stands. Active fishers used a variety of forest types especially during summer (greater diversity of food types). In winter, fishers hunted intensively in dense patches of coniferous undergrowth where snowshoe hare tracks were common, and used deciduous stands less than expected by availability.

Because of the diversity of diets, Arthur *et al.* (1989) concluded that optimal habitat for fisher probably includes a mixture of forest types including some coniferous cover and "it was not surprising that we found little evidence of active fishers selecting for a particular forest type". Habitats used by fishers in this study suggests that fishers may be better adapted to deciduous and transitional habitat rather than northern conifer forests.

Other studies document that fisher use a variety of forest types including mature conifer and mixed-confer-deciduous and forested wetlands with conifer undergrowth (deVos 1952). Allen (1983) assumed that optimum fisher habitat is mature coniferous forests. Band (1989) indicates that this might be true where deep snow inhibits fisher movement in habitats with little cover. The ideal habitat in Oregon was described as "dense mature forests, close to climax, with a large percentage of coniferous trees and many windfalls" (Ingram 1973 cited in Banci 1989).

Travel is hindered by snow depth during periods of deep soft snow. Fishers travel extensively whenever there is shallow snow or hard crust conditions. When deep soft snow is present fishers select coniferous areas where travel is easier because of lesser snow depth. Severe and extensive disturbance by logging or fire may seriously reduce its habitat value for fishers, especially during winter due to lack of overhead cover and greater accumulations of snow.

Raine (1981) found fisher to be restricted by the soft, thick snow cover during mid-winter with fewer tracks were observed at this time, and fisher travelled upon snowshoe hare trails and their own trails to a greater extent than in either the early winter period of thin snow or the late winter period of thick snow crust conditions. Fisher were also found to walk through the snow cover and leave a body drag in midwinter.

Raine (1981) found that fisher appeared to prefer rivers, lakes and coniferous ridges during the periods of thin snow cover in early winter. During mid-winter periods of soft, thick, snow conditions, coniferous ridges were the most important winter habitat component for fisher and this appears to related to prey availability (snowshoe hare). Raine (1981) suggests that both fisher and marten are more likely to be caught in the winter (due to lower food availability) and more juveniles are trapped dispersing in fall and early winter. Fisher prefer subnivean dens for protection from cold and predators and most likely prefer to den in coniferous habitats due to the availability of windfalls, decayed stumps and squirrel middens.

White *et al.* (1980) found that fisher were uncommon to rare and optimum habitat is large tree stages, regardless of crown closure, in red fir and lodgepole pine forests. Good habitat is also found in habitats with more than 70% canopy closure in mixed-conifer and pine forests. Special habitat requirements include snags or hollow trees for nest sites.

Habitat Alterations/Impacts

In Arthur *et al.* (1989) the quality of fisher habitat probably declines when stand composition is greater than 75% conifers. Mature hardwoods may still be required for natal dens and resting sites-small openings that reduced canopy closure to 50% helped maintain diversity and the abundance of a variety of prey. Fishers in Maine where found to tolerate a fair degree of human activity probably because of the extent and diversity of the forest and were not restricted by large areas of open or developed land. However, other studies have reported that fisher avoid use of large clearcuts except for foraging in the summer and forest cover may be more important in the winter (to reduce snow depth) and for resting sites (Banci 1989).

Since an essential component of fisher habitat use appears to be diversity, the impacts of clearcut logging on fisher may be decreased by limiting the size of clearcuts, encouraging irregularly shaped cuts, maintaining forested cover on ridgelines and retaining and encouraging cover in cutovers to provide for the prey of fishers (Allen 1983 cited in Banci 1989). Allen (1983 cited in Banci 1989) recommend that old snags and hollow trees be maintained for den sites and that uneven age forest management will help maintain fisher habitat requirements. As for marten, although clearcuts are used in the summer, smaller clearcuts in various shapes will affect fisher habitat less instead of creating large uniform clearcuts.

Banci (1989) noted that fishers are suspectable to overtrapping and habitat loss but do have the ability to rebound quickly.

General Biology

Food Habits

Fishers are opportunistic and have diverse diets. As with marten, fisher frequently use downed logs and brush piles for hunting. Banci (1989) listed frequent fisher prey species as snowshoe hare and porcupines *(Erethizon dorsatum).* Other foods are carrion (ungulates) voles, mice, shrews *(Sorex spp.),* moles *(Neuotridius spp.),* muskrats *(Ondatra zibethicus),* beaver, rabbit raccoon *(Procyon lotor),* marten, birds, snakes ,fish eggs, vegetation, nuts, and fruits. Hares, porcupine, deer, squirrel, small mammals and birds are staples of the fisher diet and smaller prey (mice and squirrels) become more important when large prey are available. When prey becomes more abundant, such as the snowshoe hare, fishers rely more on that prey type. Shrews, which are relatively rare in the diets of other animals, occur frequently in fisher diets.

Carrion is high during periods of seasonal abundance especially during severe winters when ungulate mortality is high. In a study in Minnesota during a severe winter when deer mortality was high, deer in the diet of fishers increased to 31% from 19% the year before (Kuehn and Berg 1979 cited in Banci 1989). Fishers eat a greater diversity of food, including fruit and nuts in summer and fall.

Banci(1989) reports evidence indicates that fishers select prey on the basis of availability and that prey switching occurs during seasonal increases in certain diet items (i.e. hare abundance). This not only indicates that fishers are adaptable, but suggests that prey diversity may be an important requirement and is reflected in habitat choices of ecotones, riparian areas and diverse rather than monotypical forests (Banci 1989). There is also well documented relationships between fisher and porcupines (as prey) which Banci (1989) thoroughly describes including hunting techniques and habit used (open upland hardwood forests).

In Kuehn (1989), the author studied fisher food habits during 8 winters when the snowshoe hare population declined in Minnesota. Fishers consumed less hare as the hare population declined but fisher condition did not decrease. Kuehn (1989) found that fisher populations are unlikely to track hare cycles and deer carrion was an important food item each winter. Although small mammals only composed a small portion of the diet (deer mice, voles, lemmings *(Lemmus spp.),* shrews, moles), small mammals became increasingly important to fishers as hares declined. If hare and grouse populations coincide during low periods, this could affect fisher.

Raine (1981) found snowshoe hares composed 81 % of the winter diet of fisher and 53% of the diet of marten. A higher percentage occurrence of hare in their diet than in any other fisher study possibly because the fisher population was high during the study and porcupines and white-tailed deer were rare. When the hare population began to decline, fisher switched to alternate prey (other species have been documented to do this). Fisher also ate microtines, squirrels and birds and differences found between the diets of fisher and marten indicate that dietary competition between species was probably not extensive. Fisher foraging behaviour is similar to marten (logs, stumps etc. investigated) but they dug holes in the snow more often than tunnelling in it and Raine (1981) suggests that their relatively large body size makes digging more feasible than tunnelling.

Home ranges and Populations

Banci (1989) reports that home range sizes are 20-34 km^2 for adult males and 15-19 km^2 for females. As for marten, home ranges within the sexes do not overlap but male and female home ranges can overlap. Adult males abandon their home ranges during breeding season (February to April) and juvenile movement during dispersal (fall) may be extensive. Home ranges in Ontario were estimated to average 26 km^2 (White *et al.* 1980).

In Arthur *et al.* (1989), the authors also found that home ranges within sexes did not overlap but male and females home ranges did overlap. Home ranges of females were stable in size and location throughout the year and males made frequent trips outside their home ranges during the spring breeding period, trespassing through ranges of neighbouring males in search of females in heat. Fishers were found to move to new areas when the previous residents were removed by trapping. Intrasexual aggression was suggested by evidence of males fighting and females shifting their movements to avoid the area used by another female.

In Arthur *et al.* (1989) median home range sizes of 25.5 km^2 for males and 12.2 km^2 for females were found. The authors suggest that 3 adult fishers (1 male, 2 female) would require about 25 km^2 for a maximum density of 1 fisher/8.3 km^2 and if young are produced (3) then the total density would be about 1 fisher/2.8 km^2 during summer and fall until dispersal.
The minimum density that could be estimated from collared fishers in this study was 1 fisher/2.8 km^2 to 1 fisher/10.5 km^2 in summer and between 1 fisher/8.3 km^2 to 1 fisher/20 km^2 in the winter.

Banci (1989) reports densities for fishers in other studies in eastern North America range from 1 fisher/0.6 km^2 to 1 fisher/18.9 km^2 while estimates from British Columbia and California are > 1 fisher/200 km^2. Banci (1989) notes that information is insufficient to estimate densities and population sizes of fishers in British Columbia.

Harvests

Although, it would be expected to see more males than females in harvest data as for marten, there appears to be a female bias, specifically in adults, in fisher harvests. Males should be more vulnerable due to their movements and greater home ranges and more of them are expected to occur in harvests and this occurs in lightly trapped areas (Banci 1989). [When more females are harvested in intensively trapped populations it likely means that there are more females in the populations and there may be too few males available to impregnate female.] Banci (1989) suggests that females outnumber males in harvest possibly because males have a higher mortality rate and females have a lower mortality rate in the wild.

Fisher and Marten

Banci (1989) summarizes the relationship between marten and fisher and concludes that , even though is has been suggested that marten may be a factor controlling fisher distribution and population levels, fisher and marten often do not occur in the same area and the two species appear to use different types of habitat. Fisher appear to occupy lower elevations and are better adapted to earlier successional stages while marten are smaller and more arboreal and better able to hunt under the snow and are less restricted by snow cover. The requirements for resting sites in winter by marten may be more specific due to marten not being as efficient at retaining body heat.

Ralne (1981) noted that two predators of different sizes, but similar morphology and hunting techniques, can coexist if each predator specializes on different sizes of prey (Rosenzweig 1966 cited in Raine 1981). In Raine's (1981) study marten ate a greater amount of smaller prey (microtines and squirrels) than did fisher, while fisher ate more medium sized prey (marmots and muskrats). The relatively high hare population resulted in both species preying heavily on hares. Marten displayed more subnivean and arboreal activity, and ate more microtines and squirrels than did fisher

Management Implications and Research Recommendations

An assessment of habitat capability for fishers is a first step in the management of habitats and populations (Banci 1989). Also, habitats important to fishers are important to other species so managing for fisher is maintaining biodiversity rather than just single species management. Fisher prefer diversity in habitats including ecotones, riparian areas, ridgelines, and small forest openings. Hares, a prey species for fisher, prefer young seral stages found in the openings and lynx (which are dependent on hare) also benefit. Species dependent on old-growth (such as marten, many species of birds, ungulates in winter) benefit if habitats are managed for uneven-aged forests (Banci 1989).

In Thomasma *et al.* (1991) the authors state that the future of fisher is dependent on upon proper management to maintain suitable habitat and to ensure against overharvest.

Banci (1989) lists specific management options such as leaving carcasses in the winter for fisher food and to aid pregnant females. More specific objectives in trapline management for fishers advocates leaving a breeding population and trapping dispersing juveniles. Large, untrapped areas will maintain a reserve population and provide insurance against population reductions and the size of reserve which is adequate depends on habitat quality (Band 1989). Therefore, determining which habitat characteristics are important to fisher and how to either enhance or create these characteristics is important.

Other trapper management recommendations are included such as monitoring the number of males and females in harvests and recommending early trapping (before January) to harvest dispersing juveniles (rather than breeding males) (Banci 1989).

In management recommendations in Banci (1989), more research applicable suggestions for the Williston Lake watershed include: (in order of priority)

1) analysis of population status relating population numbers to both habitat quality and quantity and habitat changes,
2) identification of critical habitat needs,
3) determination of densities in representative habitats,
4) development of a population model to predict the effects of differing harvest regimes,
5) determination of density and habitat use by radio-telemetry, and
6) development of HSI models to predict the capability of habitats based on information provided by Ministry of Forests inventory. This should include a protocol for testing, refining and validating models to be established.

Raine's (1981) recommendations include road closures as necessary after logging or mining are completed to prevent trappers from having easy access to wilderness areas. Both fisher and marten are easily trapped and have low reproductive potential.

Raine (1981) suggests research to see if snow depth is related to fisher mortality and to see if a relationship exists between track depth, track area and snow cover hardness.

Habitat Suitability Index Models

In Thomasma *et al.* (1991), actual testing of a habitat suitability index model for fisher was attempted. The HSI model was developed for application within deciduous and evergreen forests and forested wetlands throughout the range of the fisher (Allen 1983 cited Thomasma *et al.* 1991). Allen (1983) assumed that prey availability and the foraging strategy of fisher determined its use of habitat and that winter/early spring habitat is the most restrictive component of a fishers annual habitat requirements (as with many other animals). Dense, old growth forest stands was considered to provide suitable cover for fisher and its prey and the life requisite for the fisher HSI model was winter cover (Allen 1983 cited by Thomasma *et al.* 1991).

The authors tested the model within the Ottawa National Forest (Upper Michigan), an area where habitat destruction and trapping pressure led to the demise of the fisher in Michigan in the early 1900's and fisher were reintroduced in 1964. The most suitable fisher habitats characterized by the model are dense forested, strands comprised primarily of large diameter conifer trees that provide suitable winter cover for marten and prey. The authors found that the current model was unsuitable for use in pine plantations.

9.2.4 Lynx

Although there has been no significant population monitoring or research projects on lynx in British Columbia, the species is biologically inform throughout its North American range and findings from other areas are considered to be applicable (Hater, 1988). Hatler (1988) completed a very comprehensive summary of information on lynx including major features of lynx biology, human use, and management (and an annotated bibliography). Much of the information on lynx has been taken from this report and other literature obtained was added to this review.

Most aspects of life history, population dynamics, and management of lynx are best expressed and considered in relation to patterns and trends of hare abundance (Hatler 1988). So much of the following lynx habitat use, habitat impacts, life history and so forth are discussed with snowshoe hare requirements in mind.

Koehler (1987) noted that lynx is unique in that it is the only felid in North America adapted for the deep snow and cold temperatures of the boreal forests. Koehler (1987) also points out that lynx is a candidate for threatened and endangered because of potential over exploitation for its fur and destruction of its habitat by timber harvesting.

In Child and King (1988) lynx are considered to have moderate population levels throughout most of the watershed with a high rating near the southern end.

At this point, it is interesting to note that there has been little research done on lynx in British Columbia and it this may be a good argument for specific lynx research in Williston Lake watershed.

Habitat Use and Preference

Hatler (1988) found that most habitat designations in the lynx literature were actually were actually either detailed descriptions of study areas or were classifications of the broad vegetation types in which the study areas were located. Although, such descriptions were considered as potentially useful, Hatler (1988) divided the habitat heading into cover or climate. Climate included how weather factors could directly affect vegetation characteristics but also included such events as severe winter conditions (affecting the access of hares to their food supply) or snow conditions impeding the access of lynx to food.

Under the "cover" heading, lynx were found to use both climax and early seral stages of coniferous forest and that knowledge of the specific forest requirements of critical importance for effective management.

Hatler (1988) notes that there is little knowledge on the contribution of habitat factors to population levels of lynx and that precise habitat protection requirements and enhancement possibilities for lynx

are not yet known. Population management objectives cannot be met without a suitable interspersion of mature forest for cover and denning
(and what characteristics of mature forests fulfil these requirements) and earlier seral habitats that support snowshoe hares and provide the nutritional food for lynx population growth and expansion.

In Stephenson (1987) the author found (in Alaska) that lynx habitat quality depended largely on the ability of a given habitat to support populations of hares, and secondarily grouse and ptarmigan. In addition, alternate prey such as caribou, sheep, foxes, beaver, ground squirrels and microtine rodents were considered important in sustaining lynx in certain areas when hares are scarce so their habitat may periodically be important.

In Alaska, the largest expanses of productive lynx habitat are mixed forest in which fire aids to the development of habitat diversity by creating different successional stages (Stephenson 1987). Mid-successional vegetation stages that develop following fire provide excellent habitat for small game, especially when burns produce a diverse habitat mosaic that includes some mature spruce and hardwood forest, forest regrowth, riparian shrubs, and other habitat types. Alpine shrub thickets found near the timberline were found to be an additional habitat type important to lynx. In these areas, snowshoe hare and other small game populations appear to be not cyclic or not in phase with cycles in forested lowlands, thus providing lynx with food during periods of low food availability other habitats. The quality of the alpine shrub thicket habitat appeared to be relatively stable.

Stephenson (1987) found there was a higher proportion of shrubs and hardwoods in his study area than in areas farther south and west where fire suppression had been in effect for a longer period. He notes that not only does fires create excellent habitat for lynx, but also benefits other furbearers that use successional vegetation types.

In Quinn and Parker (1987), good snowshoe hare habitat is described as good lynx habitat because of the dependence of lynx on hare as a prey species. Snowshoe hares were found to prefer diverse forests with alternate stands of conifer for cover and shrubby openings for feeding and in parts of western Canada, upland forests dominated by aspen support high densities of both hare and lynx. The authors suggest that in conifer-dominated habitats, dense softwoods in association with openings of 2-4 ha are ideal habitats. Lynx have been found to select successional habitats and open mature conifer rather than mature mixed-wood forest. Use of conifer habitat increases during summer and an irregular pattern of logging or fire is suggested in boreal forests to produce prime hare (and lynx habitat) if forest succession is allowed to continue in a normal pattern.

Koehler (1987) found that lodgepole pine forest cover types occupied 56% of home range areas of radio-collared lynx while spruce and subalpine fir forests comprised 30% of the home range areas. Snowshoe hares were most abundant in young-aged lodgepole pine stands and habitats used by lynx coincide with areas of snowshoe hare abundance and these habitats include dense stands of conifers and hardwoods. Mature ($\geq$ 250 years old) spruce-subalpine fir forest were the preferred denning habitats, and all sites were on N-NE aspects and had a high number of fall down logs. Berrie (1973) also observed the importance of blown-down trees in providing denning cover in Alaska. Koehler (1987) found lynx occupied areas above 1370m in elevation and suggested that lynx select for areas dominated by lodgepole pine and spruce-subalpine fir forests and avoid xeric forest types and open meadows. Koehler (1990) found that in north central Washington, lynx used areas above 1463 m in elevation that were dominated by lodgepole pine and Engelmann spruce-subalpine fir cover types. Hares were the most common prey of lynx and snowshoe hares were the most abundant in 20 year-old lodgepole pine stands. The author suggests that fire suppression and natural fire frequencies in the past 5 decades had limited the amount of these early successional forests. Marginal habitat for hare probably resulted in little prey and large home ranges of lynx in the study area.

In Koehler *et al.* (1979), most (90%) locations of lynx were in densely stocked stands of lodgepole pine resulting from earlier fires (1910). These stands also supported abundant populations of hares and the authors suggest that there is no change in habitat use or range areas throughout different seasons.

In Quinn and Thompson (1987), the analysis of the data collected in their study on lynx suggests that the population density of lynx is lower in boreal coniferous forest than in boreal mixed-wood forests

and boreal mixed-wood region had more forest in early successional stages from logging, burn, or insect damage than the true boreal coniferous forests. Since hares prefer early successional stages than mature forest, it is not surprising that lynx were also found in those forest types. Quinn and Thompson (1987) suggest that the carrying capacity for lynx in mixed forests may be high since the mixed forest provided a more heterogenous and disturbed (logged or burned) environment than true boreal forests. It was also possible the classification of forest used was too broad to measure lynx habitat quality and other publications have suggested that forest cover types may not be adequate units for defining different furbearer habitat.

In a more general publication (Canadian Trapper), Todd (1985) points out that lynx is often considered an inhabitant of wilderness area and while this is generally true, lynx are also tolerant of human disturbance. For example, since the early 1960's, lynx have occupied the partly cleared mixed farming district in central Alberta and the author believes that the lynx is quite tolerant of human activity if unmolested.

Since lynx are so closely tied to snowshoe hares a brief description of snowshoe hare habitat is included. White *et al.* (1980) describes snowshoe hares as found in higher elevational zones in riparian deciduous, alpine meadows, and conifer stands. Hares seem to prefers earlier successional stages in pine or fir stands. Special habitat requirements are described as thickets of alder, willow, and young conifers and hollow logs.

General Biology

Food Habits

Hatler (1988) found that in all literature reviews, snow shoe hare was the no. 1 ranking prey, even during lows in the hare cycle. Lynx were also found to consume red squirrels , mice and voles, various birds (especially grouse) and ungulates (both as carrion and direct prey especially young animals). Stephenson (1987) also noted the importance of snowshoe hares to the lynx diet and also included grouse and ptarmigan as secondary prey and alternate prey such as caribou, sheep foxes, beaver, ground squirrels and microtine rodents. Koehler (1987) found that snowshoe hare occurred in 79% of lynx scats and tree squirrels occurred in 24% of scats. More (1979) found only four food species were represented: snowshoe hare 83.3%, grouse 16.6%, red squirrel 55.5%, red-backed vole 5.5% (by frequency of occurrence). Both hare and lynx were at the low points of cycles.

In Todd (1985), the author states that the hare population is believed to crash because of two successive interactions. First, a hare-food interaction as hare populations increase and hares overbrowse their range and second, a hare-predator interaction as an over burden of the predators keep the hare decline continuing. Hares remain the chief food
source for the lynx during the decline but alternative foods are inadequate, particularly during the winter. Todd (1985) reports the proportion of kittens in the lynx populations in the winter dropped from 66% during hare abundance to 3% during hare scarcity and suggests there should be a curtailment of trapping up to 3 years after the crash (since kits would be nil at that time). Other reasons for overall lynx population declines are mentioned including both temporary and permanent habitat loss, severe winters, as well as decreased snowshoe hare populations.

Hatler (1988) summarizes the importance of hares to lynx and points out "when hares are abundant, adult lynx may be relatively secure, maintaining weight, condition, high pregnancy rates and large litter sizes, all within well-defined home ranges and with minimal activity and effort. Adequately nourished kittens survive well and develop quickly, such that females may produce litters in their first year. With such productivity, and apparently lacking any regular non-nutrition related source of natural mortality, lynx populations have a large potential for increase."

"When hare numbers decline, the nutritionally dependent lynx enter a period of relative stress, which may be manifested at the individual or population level by some or all of the following symptoms:

- reduced physical condition,
- increased activity and movements,
- increased home range size or, in some cases, abandonment of home ranges,
- long distance dispersal and attendant local "irruptions",
- decreased productivity especially among yearlings,
- poor survival of kittens, and/or
- starvation of at least some adults".

Home ranges

Hatler (1988) discusses the difficulty involved in compiling , summarizing and interpreting data on lynx home ranges. Most importantly, lynx appeared to increase home range sizes when hare density decreased and that home ranges are abandoned in favour of dispersal nomadism when hare abundance falls below a certain level. In Alaska, home ranges varied from 4.0 to 10 ha) with averages of 5 to 6 ha (White et al. 1980).

Koehler (1987) suggests that more area specific studies are needed to accurately understand habitat requirements of lynx rather than just drawing previous literature not in the same area. Koehler (1987) found home range sizes for females is 41.5 km^2 and for males is 67.8 km^2. Lynx were found to use well defined home ranges areas or territories that are maintained during all seasons and exploited ranges home ranges sizes are 2 to 8 times larger. Densities were found to be 2.3 to 3.1 lynx/100 km^2 and can approach 20 lynx/100 km^2.

Harvests

Hatler (1988) discusses the role that trapping plays in lynx mortality (mostly from trapping) and how nutritional factors play an important role. Since animals that are responding to food shortages by increasing activity and movements are more likely to encounter trap sets and animals that are starving are less likely to be cautious at baited sets.
Vulnerability to trapping may also vary with age (experience), sex, winter severity, stage of the season, and trapping method. Hatler (1988) suggests (as do many others) that peak lynx harvests may reflect maximum insecurity of the populations following hare declines, while low harvests may result from low overall numbers and/or low average vulnerability of the remaining population. Although trapping mortality may largely replace natural mortality in some areas and at some stages of the cycle, trapping may also be additive to the cycle, further depressing numbers of lynx. At this point, the management significance of mortality as determined from harvest records has been difficult to determine.

Quinn and Thompson (1985) found that male lynx are considered to be more vulnerable than females to trapping due to larger home ranges. Yearlings dominated the harvest due to either inexperience with traps, dispersing populations, or population numbers possibly increasing.

In Quinn and Thompson (1987) the authors found that the biological basis of lynx population management is deficient and the impact of commercial trapping on lynx populations is not fully understood. They compared population structure, mortality, productivity, and condition of lynx from zones of distinctly different harvest density and forest type in northeastern Ontario and found that population parameters were remarkably consistent and showed little variation. Trapping accounted for nearly all mortality (during the period of the study) and it was concluded that males, especially yearlings, were the most vulnerable to trapping. Mech (1980) also found that males more vulnerable to harvest than females.

Stephensen (1987) discusses harvesting in Alaska and concludes that lynx cycles are not always synchronous over large areas and harvest trends may not always reflect population trends. The author suggests that a regional approach to lynx management (with regulations as simple and consistent from area to area as possible) may be more appropriate than localized management because lynx sometimes move large distances in search of food. The overall welfare of lynx populations in large areas depends in part on lynx dispersing from small areas of abundance and there may be pockets of high or low lynx with either restrictive or liberal seasons.

Management Implications and Research Recommendations

In Hatler (1988), the author identifies the most pressing information needs in B.C. as a better understanding of snowshoe hare distribution, biology, and cycle patterns in the diverse ecological zones of the province, and the habitat requirements and relationships for both hares and lynx in those areas. Further research is required for aspects of hare biology and lynx habitat use to determine precise habitat protection requirements and enhancement possibilities for lynx (and hare). Halter (1988) suggests forestry topics that need to be addressed include:

- fire suppression, as it may limit production of new hare habitats,
- compatibility, by vegetation zone or region, of hare habitat enhancement and forestry/silviculture objectives,
- cutblock size and juxtaposition with adjacent habitats, and
- silvicultural treatments that may affect hare production.

Hatler (1988) points out that forestry matters relating to lynx management do not have to be limited to the above list. Other research needs are identified including obtaining additional information on population dynamics. (However ongoing research in Alaska and the Yukon may suffice for information needs in B.C.) Population monitoring is important including selected snowshoe hare trend surveys and trapper cooperation. Trappers are very important in long-term lynx management since trappers can protect remote lynx refugia on their trapline during cyclic lows, minimizing use of non-selective trapping methods and practising local habitat improvement.

In harvest management Hatler (1988) recommends a tracking strategy as the most appropriate for managing harvests of the cyclic lynx by decreasing harvest pressure during the period of low population and recruitment and increasing it when population performance improves. Better data is needed through harvesting in conjunction with population research to better anticipate cycle lows and highs.

Koehler's (1987) recommends that in order to adequately determine lynx status and implement management programs to ensure its status and survival an understanding of the basic ecological requirements of lynx is needed. The author points out that the lynx needs to be studied in its southern range since other studies have been done in the north.

In Koehler (1990), the author recommends using GIS inventories of potential habitat for lynx to provide regional estimates of lynx numbers for population management and to identify areas for habitat management. Management of forest pests, timber harvesting, and road access are needed for minimizing the impact of these practices and natural or prescribed fire and timber harvesting have negative short-term impacts because of reduced security cover for lynx and hare, but successional forest benefit both species and can be managed to enhance habitat conditions for lynx. Koehler (1990) cautions that the number and size of openings be limited, creation of early successional forests as habitat for prey be encouraged and mature forest be protected for denning habitats.

Stephensen (1987) states that it is difficult to evaluate the effects of harvest on lynx population fluctuations because of the problems with surveying (censusing) a generally solitary, secretive and cyclic furbearer. Population dynamics and changing characteristics of trapping should be considered when evaluating management options and Stephensen recommends a tracking harvest strategy as per Hatler (1988).

However to implement such a program requires research into changes in population growth or decline. Population fluctuations are highly variable and are influenced by many factors (including habitat conditions, other predators, and possibly trapping) which should also be quantified in terms of impacts.

Slough (1986) suggests that refugia are critical to the survival of lynx due to the high trapability of the species and although refugia presently exist, their distribution is not optimal and overtrapping is locally extensive. Refugia receive no protection under legislation (in Alaska) and Slough suggests a system of quotas and restrictions on trapping intensity could alleviate these weaknesses.

Slough (1986) recommends the significance of refugia be examined by field studies of lynx population dynamics (especially mortality factors and the interdependence of compensatory and non-compensatory factors), movements (trapability) and densities in trapped and untrapped areas.

Brand and Keith (1979) are extensively quoted in other papers. These authors document lynx decline with hare decline and estimated by curtailing lynx trapping during 3 years of population decline, the total Alberta lynx harvest during 5 years of subsequent increase would be greater than that of a continuously trapped population. The authors suggest a curtailment of lynx trapping for 3-4 years starting with the second year after the peak in fur harvests.

Schwatz *et al.* (1988/90) suggest that to properly manage lynx according to the recommendations of Brand and Keith (1979), both an accurate estimate of lynx densities and an assessment of kitten production and survival. The authors give useful suggestions for tracking and note that management decisions based upon results of the line transect census would have resulted in accurate management decisions.

Quinn and Thompson (1987) mention that if trapping is to be curtailed during lynx declines, then selective trapping techniques must be developed (since lynx often caught in red fox sets). They suggest using live traps and that determining optimum levels of harvest of increasing lynx populations is also a difficult problem.

Bailey *et al.* (1986) found that the majority (66%) of lynx harvested from 1977-84 came from remote habitats rather than accessible prey-abundant habitats and although there was abundant habitat and prey there was low lynx numbers and harvest. Research is needed since the minimum size of refugia needed to maintain viable populations of lynx where they are cyclic is unknown and the minimum area required by individual lynx to survive periods of snowshoe hare scarcity is unknown. These authors also note that fisher are similar in many aspects to lynx (reproductive rate, population density, food habits, cyclic with hare and high vulnerability to trapping). Models of fisher populations suggest that the mere removal of > 1-4 individuals/100 km^2 per year could cause local fisher extirpation, perhaps over much larger areas.

Todd (1985) notes that lynx harvest may peak before lynx populations have actually peaked and a variety of other variables can account for reduced lynx peaks including permanent habitat loss, temporary habitat loss, severe winters, industrial development and snowshoe hare population levels. Trapping should be curtailed during a decline in population or decline in recruitment.

O'Connor (1984) recommends that long-term studies are especially important of understanding the ecology of cyclic species such as lynx because factors influencing the populations may vary during the span of the cycle. O'Connor points out that a 2-3 studies yield accurate information regarding the current situation for a population but provides little insight into the long-term population dynamics. O'Connor's thesis provides a complete account of a 10-year cycle in hare and lynx and the author notes that population declines are detected after they occur by examining harvest records and lynx reproduction may have declined for several years and it may to late for an effective management responses.

Trostel *et al.* (1987) related the causes of mortality of snowshoe hares to density of hares over an eight year period and used simulation modelling to examine whether these density-dependent relationships could relationship similar to those observed in their study area. They found that predation in winter is the largest mortality factor for snowshoe hares at their study site and it was possible that food shortage during winter acted indirectly to limit hare population size, by making hare more vulnerable to predators. The lack of information about juvenile hare demography is a problem and their model shows that a simple interaction between snowshoe hares and their predators in winter in the Yukon can produce cyclical populations. Winter predation can initiate the decline from peak hare densities as well as reduce the population to extremely low densities. Additionally field experiments are necessary to test the prediction of this model that winter predation is sufficient to cause a 10 year hare cycle.

9.2.5 Wolverine

Although there has been no significant population monitoring or research projects on wolverine in British Columbia, species information has been collated from other studies throughout North America (especially the Yukon and Alaska). Hatler (1989), has completed a very comprehensive summary of information on wolverine including major features of wolverine biology, human use, and management (and an annotated bibliography). Much of the information on wolverine has been taken from this report and other literature obtained was added to this review.

In Hatler (1989), wolverine is characterized as one of Canada's rarest mammals. Its' relationship with humans and its reputation in North America has developed mainly on the wilderness trapline, where it has often been considered more a competitor and nuisance than a resource.
Hatler describes the sparsely occurring wolverine as a unique and interesting animal, possibly serving as an indicator of the health and productivity of local environments better than any other, and certainly standing as a challenge in resource use and management. Historically the wolverine is believed to have been present in most Canadian provinces (although it has never been abundant in the east). Currently it is rare throughout most Canada except in the extreme north of most provinces and in the north and west (Alaska, Yukon, NWT, British Columbia). In British Columbia

the highest and most consistent production of wolverine is in mountainous management units in the north (Omineca-Peace and Skeena Sub-regions) and in the southeast (Kootenay Region).

White *et al.* (1980) describe wolverine as rare and historically, never present in large numbers although numbers thought to be increasing in California. There is scant data on home range, movements, and habitat requirements.

Habitat Use and Preference

Hatler (1989) describes wolverines as mainly occurring above the treeline, especially in summer. Spruce and fir forests are often used for resting and foraging cover in winter, and some individuals descend to lowlands along rivers and lakes utilized as ungulate winter range. High elevation conifer forests appear to be a regular feature of wolverine habitat in most areas, although one study north western Alaska existed found wolverine year-round in the open tundra.

Snow is considered an important component of the wolverine's seasonal habitat, providing a deep insulative layer over the den where young are born in late winter and often negatively affecting other wildlife, especially ungulates, that become available as carrion from predation or winter kill (Hatler 1989).

There has been some speculation that changing weather patterns be could be a problem. Milder winters combined with habitat loss could have decreased both carrion and resting and foraging habitat for the wolverine.

Hornocker and Hash (1981) found wolverines exhibited fidelity to a given area although they may move to other areas for a short time. Males and females used similar areas in elevation for all seasons with a pronounced trend from lower elevation winter areas toward higher spring and summer areas and intermediate elevation areas in the fall. 70% of locations in large areas of medium or scattered mature timber and Abies lasiocarpa types accounted for the majority of relocation sites. Seral lodgepole and western larch sites were frequently used. There appeared to be strong selection for these alpine fir types in the summer; those types occurred at the higher cooler elevations sought by wolverines in hot weather.

Food was apparently more available, either as carrion or prey, in the mature or intermediate timber stands preferred as wolverine habitat, especially edge and ecotonal areas around cliffs, slides, blowdowns, basins, swamps, and meadows (Hornocker and Hash 1981).

Cover provided by mature or intermediate timber is also important in habitat selection. Wolverines appeared to be reluctant to cross openings of any size such as recent clear-cuts or burns. Tracking revealed that wolverines meandered through timber types, hunting and investigating, but made straight line movements across large openings. Tracks further indicated they often ran or loped across large openings. Individuals often bedded in snow on open outcrops (easterly and southerly aspects used most often) that were all in timber types which afforded cover (Hornocker and Hash 1981).

Hornocker and Hash (1981) conclude that "the wolverine's niche explains the relative rareness of the species in the community compared with the efficient hunters among the carnivores that act as predators, and it implies a direct relationship between the biomass and turnover of large herbivore populations and the abundance and distribution of wolverines".

Hash (1987) describes wolverine as occupying a wide variety of habitats but primarily occur in boreal forests and tundra areas. Wolverines generally occupy back country or wilderness areas that have little human activity of development and usually are only seen in areas of development when these areas are adjacent to remote habitats. Apparently wolverines are reluctant to cross large openings, often skirting edges or running and loping across in a straight line in contrast to the meandering travel patterns commonly displayed within timbered areas. Rivers, highways, rugged mountain ranges, or other geographic barriers don't appear to limit the travel of wolverines and large home ranges are generally tracts of unbroken wilderness and include marsh, alpine tundras and forested areas. Ecotonal areas appear to be important habitat components.

Van Zyll De Jong (1975) discussed as probable causes for observed changes in distribution and abundance of wolverines, exploitation by humans, decline of caribou populations, and possibly wolf control. The author suggests that wolverine ecology needs to be understood before the effects of the different components on wolverine distribution and abundance. At the time of publication, the author found that climate and habitat remained either unchanged or changed so slightly during the period under consideration that they were dismissed as possible causes. However, there may have been major climatic changes in more recent years (milder winters) which may have had an effect. Evidence suggested that exploitation by man has contributed to the decline of wolverine and wolverines tend to be less abundant then wolves even in optimum habitat. Wolverine seem to have a reduced ability to compensate for losses due to human exploitation and available evidence suggests that the changes in distribution of the wolverine may be attributed to predation by humans, decline of caribou populations, and possibly also indirectly to wolf control.

White *et al.* (1980) describe wolverine distribution as scattered, mostly near timberline. Optimum habitat is considered to be in mature timber with moderate to dense canopy cover in red fir and lodgepole forests, and in alpine meadows. Special habitat requirements are listed as low human disturbance, rocky areas, caves, logs, or snags as den sites. Wolverines excavate burrows under shelving rock or in logs, caves or snags.

General Biology

Food Habits

Hatler (1989) describes the wolverine as basically a scavenger but as able to obtain its own food. Foods in summer are eggs and young of ground-nesting birds, various mice, voles, and berries, and wolverine may focus particularly on burrowing rodents (marmots and/or ground squirrels in most areas. In the winter, ungulates such as moose, caribou and elk (*Cervus elaphus)* (usually as carrion) form an important part of the diet. The maximum amount of carrion from animals dying of starvation or from predation by larger carnivores such as wolves and cougars (*Felis concolor)*, is usually consumed during February or March coinciding with the birth of the young. Extreme hunger seems to be a regular feature of wolverine existence, and individuals may survive for long periods on the most meager diet (but females are unable to raise young under these circumstances). In general, Hatler (1989) suggests that the most severe winters in terms of ungulate survival may be the best years for the well-being and productivity of wolverines due to the amount of carrion available.

Late winter nutrition may be a major factor in individual productivity with the failure of females to complete pregnancies or poor survival of kits. Females don't breed until their second year (with 1-3 kits per litter) and many at that age don't produce young at all dependent on the condition of the animal (Hatler 1989).

Researchers (following tracks) report that the animal is simply "looking for something to eat" rather than truly hunting and the wolverine often follows tracks of other carnivores (wolves, fox, lynx) and regularly uses food items cached or left by those species (Hatler 1989).

Hornocker and Hash (1981) state that wolverines are adapted for carrion feeding and found carrion occurs most frequently in wolverine diets in the winter with elk and/or deer occurring in 27% of scats. Wolverines possess an extremely keen sense of smell and can locate food under deep snow. Wolverines also were found to kill smaller prey such as hares and marmots (they hunted brush piles, log jams, and heavy cover). Food availability was considered by the authors to be the primary factor determining movements and ranges of wolverines. Food availability has been considered factor in changes and distribution of wolverine populations in Canada (Van Zyll de Jong 1975).

Magoun (1987) found that diets reflected annual and seasonal changes in food availability and the summer diet was more varied and contained more freshly killed prey items than the winter diet. During the winter, food was obtained primarily through scavenging. There were no wintering populations of large herbivores although wolverines were able to survive the winter, their reproductive potential may have been limited by food shortages.

Magoun (1985) found that food was apparently limited during the winter months and influenced wolverine movements and productivity. The presence of caribou and moose was suggested as the most important factor influencing wolverine populations in northwestern Alaska.

Sullivan (1986) found that the wolverine is sympatric with the snowshoe hare across the boreal forest of North America. The author suggests that it is likely that a predator-prey relationship has evolved whereby hares would presumably avoid using an area that was freshly marked by a wolverine rather than risk being preyed upon. The strength of the response of prey may be directly related to the initial concentration and age of the scent mark. Sullivan found that hares avoided on feeding on seedlings associated with wolverine urine.

In White *et al.* (1980) wolverine are described as a solitary hunter foraging on ground, in trees, burrows, and rock piles for carrion or live prey. Wolverine capture prey by digging an animal out of its burrow, by pursuit and capture, or by ambush. Prey include marmots, gophers *(Thomoys* *spp.)*, squirrels, rats, mice, birds, insects, and occasionally ungulates with fruits also eaten.

Home Ranges and Populations

Home ranges can be 600 km^2 or larger in area, although only a portion of that total area may be used in any one season and separate home ranges are maintained based on sex (Hatler 1989). Adult males have the largest home ranges and may contain ranges of up to 4-6 females in summer (mostly late May through July) when breeding occurs. Wolverines are usually active during daylight hours and can move up to 20-30 km per day depending on the season and food availability. An animal that has found a concentrated food source such as a large carcass may remain at that site for 3-4 weeks.

Van Zyll De Jong (1975) suggests the animal's propensity for wandering far and wide, increases its chances of finding widely scattered and immobile food. Magoun (1987) found that wolverines will leave an established home range when food is scarce.

Wolverines can either be residents or transients and local densities can be 1 wolverine/50km^2 to 1 wolverine/100km^2. However studies that have determined local densities have generally been unable to adequately account for transients, which may be particularly important in both harvest and population maintenance Hatler 1989).

Hornocker and Hash (1981) found that an accurate determination of wolverine populations for the entire area was difficult and wolverines utilize a much larger area than other mustelids. Geographic barriers, such as mountain ranges and large rivers, confine some species but wolverines regularly cross these barriers. Wolverines occur at low densities and even in optimal habitat are less abundant than other carnivores and the authors found the densities in their study area at 1 wolverine/65km^2. Van Zyll de Jong (1975) suggest wolverine abundance appears to be related to large herbivore populations and where wolverines are still common there are large and diverse ungulate populations. The study area in Hornocker and Hash (1981) supported large and diverse populations of ungulates and also numerous species of carnivores.

Harvest

Mortality is usually caused by trapping or starvation and wolverines have also been killed by wolves (predators/competitors). Male wolverines and juveniles are trapped more often and all wolverines appear not all equally trappable (Hatler 1989). Both experience and condition play a role in the difference between individuals being trapped. For example, females with developing young may need more food and may be more trappable or juveniles with less trap experience. One trapper suggested that the development of humane traps that immediately kill animals do not allow wolverines to gain experience by being caught in a trap that they can work they way out of.

More and better harvest data is required protect the most secure and productive members of the population and maintenance or refuge areas to produce dispersing animals both for harvesting and recruitment is required (Hatler 1989). Trappers need to avoid trapping intensively for wolverines in all portions of each trapline.

Magoun (1985) recommends attempting to obtain more accurate harvest statistics and baseline data to establish wolverine population size and structure in northwestern Alaska.

Management Implications and Research Recommendations

Hatler (1989) points out that no particular habitat components or habitat management techniques can presently be singled out specifically for wolverines. Undescribed refugia appear to be of major importance, and the success of the wolverine in B.C. to date, may relate to the availability of large areas of remote, rugged uplands that are difficult to access to humans, and which have rarely been subject to competing land use. However, this as changing as logging is moving to previously undisturbed areas. Halter (1989) suggests that the presence and viability of wolverine populations relates to the viability of the entire local ecosystem and a broadly focused, integrated approach that promotes and protects biological diversity and richness is required for wolverine.

Hatler (1989) suggests that census of wolverines over large areas would be impractical and in the foreseeable future, the only significant source of information about wolverine populations will be trapper. The importance of trapper cooperation in providing reliable harvest data and replies to questionnaires is emphasized by Hatler.

Dagg and Campbell (1974 in Hornocker and Hash 1981) state "almost nothing is known about the density of wolverine populations in North America or about their exact distribution". They recommend extensive research be initiated "on wolverines in their native habitat. Radiotelemetric tracking should enable biologists to determine the territorial needs of individuals..."

In Hornocker and Hash (1981) concluded that wilderness or remote country where human activity is limited appears essential to the maintenance of viable wolverine populations and there were no differences found between the wilderness and non-wilderness portions of the study area, nor was wolverine movement, habitat use, and behaviour different. The non-wilderness portion, was used primarily for logging and recreation with the whole area bordered by rugged, relatively inaccessible mountains (wolverine went there in summer). In such habitat manipulations (clearcuts, burns) with wolverine ecology in mind, the authors suggest that consideration should be given to size, shape, and aspect of individual clearcuts. Wolverines in this study preferred basins, southerly and easterly slopes and edge and ecotonal areas and these areas should be left intact. The authors also suggest strictly regulating road access in the winter.

In Magoun (1985), management considerations for furbearers for optimum sustained yield of economic benefits recognizes the status of food resources as the most important factor. The bottom line was the successful management of wolverines is directly related to successful management of caribou and moose as food resources especially during the winter.

In Banci and Harestad (1988) the authors discuss that knowledge of reproduction is central to population dynamics of wolverine and essential for determining timing and rates of harvest.

9.2.6 Coyote

Most studies on coyote have dealt with the aspect of predator-prey relationships, generally with the coyote being considered a nuisance predator around agricultural areas. The B.C. Wildlife Branch (1980) describe coyotes as generally social animals but function as both single individuals and family units consisting of mated pairs and their pups. Occasionally a larger pack is seen, particularly in winter in areas in areas where they feed on ungulates dying from other causes.

Although there has been some research on coyotes in British Columbia, species information has been collated from other studies throughout North America mainly from Voight and Berg (1987). Other information regarding habitat use have been added from other studies and the coyote management plan for the B.C. Wildlife Branch (1980).

Habitat Use and Preference

In Voight and Berg (1987) coyotes are found to occupy a broad range of habitats, from grasslands to boreal forests. Almost any habitat, including urban areas, that supports prey population also supports coyotes. Even where coyotes have been introduced by humans, they have adapted to their new habitat (Fisher 1975 cited in Voight and Berg 1987).

Coyote distribution is limited by snow or arctic conditions, prey size and density (with general north to south increase in availability of small prey), and competition with larger predators (wolves and cougars). It has been suggested that in Michigan, where coyotes usually lived on the prairies of southwestern Michigan, that the coyotes moved to the north after the woodlands were cut. There is a possibly that the that logging large tracts of area in the Williston Lake watershed could have the same effect.

B.C. Wildlife Branch (1980) states the preservation, maintenance or enhancement of a species is directly related to the condition and extent of its habitat. With predator that is as adaptable as the coyote, any habitat that has an abundance of prey likely to be used. The coyote's adaptability is due to both its flexibility in hunting and feeding habits. Areas that have been burned, logged or opened and have abundant 'edge' provide habitats for a variety of species that are utilized by the coyote. Coyotes are most frequently found in parkland, alpine tundra, desert, open prairie and thinned timber stands and specific habitat components of the coyote may include hunting runways, denning areas, and migratory routes in mountainous areas. Alteration of wildlife habitat is not as critical for this species as it is for other wildlife species due the coyote's high adaptability.

In western Montana, Reichel (1991) found that coyotes used hunted in riparian and brushy wash habitats where higher vole densities (their major prey) were found. Todd *et al.* (1981) found that coyotes hunted in forested habitats during the years of high snowshoe hare populations and then switched to open habits during years of low snowshoe hare populations when mice were consumed most often. Reichel (1991) suggests that generalist predators such as coyotes modify their hunting to suit local conditions and often favour small areas where seasonally preferred prey species concentrate. In northern Michigan, coyotes used edges between forested types and openings for hunting (Ozoga and Harger 1966). Coyotes appeared to prefer mixed aspen-conifer and swamp conifer sites as well as lowland brush habitat while upland hardwoods were avoided. Since deer and snowshoe hares were the most important in the winter diets of coyotes, in this area, and these species occurred in these habitat types, it was not surprising that coyotes also used these habitats.

White *et al.* (1980) found that coyotes occur in almost every plant community and successional stage. Habitat preferences included grass-forb and shrub-seedling-sapling stages of all plant communities. Listed under special habitat requirements include rock outcrops, caves, hollow stumps or logs, or deep, loose soil for den sites.

Todd *et al.* (1981) found changes in habitat use accompanied the dietary shift to and from consumption of snowshoe hares over the course of the hare cycle.

General Biology

Food Habits

Voight and Berg (1987) found an abundance and availability of food affect both coyote density and reproduction. Fluctuations in coyote abundance have been related to the abundance of rodents, carrion and snowshoe hares and to social intolerances mediated by food supplies. Hares are common in the winter diet of coyotes and may be the major food. Small mammals (voles and mice) are also important items in the diets of coyotes especially during a spring, summer and fall. Livestock carrion can be important when other prey are scarce during winter. While wolves generally eat beaver-size or larger prey, the coyote's body size, bioenergetics and flexible social structure enable them to prey on animals of all sizes. Generally, coyote food habits and tracking studies have shown that larger ungulates are eaten as carrion. However, when snow impedes deer movement, coyotes may be important predators on deer.

Fawns are frequently consumed as both carrion and prey during early summer. Coyote diets also include plant items such as fruits, berries and seeds. Coyotes are active day and night, with peaks in activity occurring at sunrise or sunset and wolves can influence the movements and distribution of coyotes by preying on them or causing avoidance behaviour. In areas with relatively stable prey populations, coyote populations are also likely to be relatively stable.

In western Montana, Reichel (1991) found that voles were the most important food source throughout the year with young ungulates being utilized more in the spring and summer and insects and fruit eaten more often in late summer.

In Hamlin *et al.* (1984), 90% of fawn mortality was related to predation by coyotes and fawn mortality was lowest when microtine rodent populations were highest. The authors recommend that managers should determine alternative prey population levels and cycle phase before making decisions on predator control for healthy deer populations.

In a study of coyote foods in coniferous forests in Oregon (Toweill and Anthony 1988), the dominant food items were fruit, rodents, large ungulates and hares and diets changed by season in response to prey availability. Coyotes are considered to be opportunistic feeders with general diets and deer and snowshoe hares made up the bulk of their diets in the winter. Many coyote food items were associated with clearcut areas and the variety of animals was greater in the spring and lowest in the winter and fall. Clearcut areas in the coniferous forests provided openings in the forest canopy where fruit bearing plants grown and indirectly because potential prey species are attracted to clearcuts.

Todd *et al.* (1981) cite studies demonstrating the opportunistic nature of coyote feeding and describe the diet as varied with food use determined largely by availability. The authors found a functional response by coyotes to the fluctuation of snowshoe hares. Hare biomass in the coyotes winter diet changed 0 to 77% as a result of changing hare density. Also , the authors point out that responses of coyotes have been tied to the abundance of microtines. Clark (1972) also found that coyote population numbers are linked to hare densities (75% of the coyotes' diet) and food levels play at least some role in determining long-term coyote density. Predators (i.e. wolves, man) can also influence coyote densities. Murie (1945) found in B.C., the snowshoe hare is abundant and easily obtained and thought to be the staple food of the coyote.

In Messier *et al.* (1986), the authors found that in winter, coyotes preyed primarily on fawn and older deer, but not necessarily individuals in poorer physiological condition. The authors concluded that coyotes may have an impact on deer numbers in southern Quebec and that more study is needed on coyote impacts. Winter diets of coyotes in Northern Michigan were to found to consist mainly of white-tailed deer (both as carrion and prey), with some consumption of snowshoe hares and smaller rodents. Nellis and Keith (1967) found that carrion provided at least one-half of coyote's food especially during winter. Mice were next in importance in the diet and their use peaked in summer and autumn.

Andelt *et al.* (1987) found coyote diets varied among years due to successional changes in vegetation and changes in prey abundance. Coyote diets were found to vary seasonally, reflecting changing abundances of a wide variety of food, items, differential vulnerability of prey, effects of plant phenology, and weather conditions. Mammals made up about 64% of coyote diets whereas insects and wild fruits comprised 10 and 20% and birds were less than 5%.

Todd (1985) found that the consumption of hares declined as hare numbers decreased, uses of other native prey, and 'other' foods generally increased in both boreal forest and adjoining agricultural habitats. Alternate foods were apparently not adequate during hare scarcity in the forest, as rates of total food consumption by coyotes appeared to decline. Habitat use changed as snow depths increased.

The B.C. Wildlife Branch (1980) describes coyotes as eating small rodents, birds, domestic poultry, the young of larger mammals and occasionally adult deer, snakes, amphibians, insects and other invertebrates are sometimes consumed. Although the coyote is primarily carnivorous, its diet may be supplemented by plants and fruits. Coyote prey varies and is based on availability and ease of capture on a scale large enough to furnish a staple food supply. The efficiency of the coyote as a predator on small mammals has beneficial to man in controlling rodents and coyotes can also prey upon domestic livestock. In Hamlin (1979), observations suggest that the cooperative strategy enables coyote to be more effective predators on young cervids.

Weaver (1977) found differences in population indices occurred between areas in Wyoming and these differences were attributed primarily to differences in the amount of ungulate carrion during winter. Northern pocket gophers, field voles, and ground squirrels were the principal foods in the May-October diet of coyotes. Coyote fed primarily upon ungulate carrion during winter (but they could survive for weeks on little fresh food).

Gier (1968) found coyotes eat the most readily available meat
with rabbits and field mice as generally preferred foods. Livestock, poultry, insects, and fruits were also utilized to meet nutritional requirements for food. When rodents are scarce, only about 30% of females provide litters as compared with 80% when food is abundant.

Hoffman (1979) suggests that winter food supply is the critical factor limiting coyote densities in Curlew Valley and throughout the Great Basin. Diets were found to be different in Utah and Idaho with jackrabbit comprising half the year round diet of coyotes in Utah but only 10% in Idaho. Rodents were the principal prey consumed in Idaho (35%) . A comparison of three ecologically different areas in Idaho revealed several disparities which probably reflected differences in prey availability.

In White *et al.* (1980) food habits of the coyote in California included mice, ground squirrels, gopher, rabbits, insects, carrion, fruits, and occasionally birds and deer fawns. Prey were often chased and captured in the open or dug out of ground.

Home Ranges and Population Characteristics

The B.C. Wildlife Branch (1980) describes coyote movements as influenced by such factors as climate and abundance of food. Coyotes don't normally appear to follow any distinct movement patterns in day to day travels.

Dispersing pups can move 30 to 50 km away but can move up to 640km. Coyotes living in mountainous areas may undertake seasonal migrations to high country in summer and to valleys in winter, possibly in search of prey species.

Voight and Berg (1987) describe home range sizes as differing between sexes and among seasons, habitats and geographical area. Coyotes living in packs and defending ungulate carrion during winter may have smaller home ranges than coyotes living in pairs or living alone. A single home range may be inhabited by a family of two or more generations, a mated pair or a single adult. In Messier and Barrette (1982) the authors conclude that group living in coyotes results from delayed dispersal ofjuveniles. By group living, the juveniles benefit individually from a secure place to forage and live, and probably have a higher survival rate until they disperse. Group living is found to be useful in hunting large prey.

Voight and Berg (1987) found a broad range of home range sizes in the literature from an average 4-5 km^2 in Texas to seasonal averages of 55-143 km*2* in Washington. Breeding generally occurs in

February and the young are born April to June. Juveniles usually begin dispersing after age 5 months and continue to disperse throughout the winter. White *et al.* (1980) found in Sierra Country, home ranges varied from 1000 to 10,000 ha and movements varied according to season.

In Idaho, home range use by coyotes was found to vary on a spatial and behavioral basis (Laundre' and Keller 1981). Behaviorally, coyote home ranges consisted f core areas where animals spent extended time resting and/or hunting and periodically ranged out to areas that surrounded or were adjacent to core areas.

Voight and Berg found that coyote is probably the most extensively studied carnivore (Bekoff 1982) and considerable research has been conducted on population dynamics. However, because of the coyote's broad geographic range, density information should not be extrapolated from one study to another.

Voight and Berg (1987) found in Alberta, summer densities range between 0.2 coyote/km^2 to 0.4 coyotes/km^2. Winter densities were 0.1/km^2 when snowshoe hares were scarce and .4-.6/km^2 when hares were abundant. Coyote densities appear to be lower in northern North America although few studies have accurately determined densities. In White *et al.* (1980) population densities varied from 0.02 coyotes/40 ha to 1.2 coyotes/40 ha. Two or more coyotes will often cooperate while hunting.

In a study in Jasper National Park, Alberta (Bowen 1982) the average home range for males and females coyotes was about 14 km^2. Home ranges were used for considerable periods (even for life). The authors point out that when coupled with ecological and behavioral information, the size, shape, and utilization distribution of home ranges become meaningful biological parameters.

Todd (1985) found that population dynamics appear to differ markedly between boreal forest and adjoining agricultural habitats.

In a study dealing with coyote removal (Davidson 1980) interpretations indicate that substantial fall-winter removal rates are ineffective in reducing coyotes. The author found the resilience to fall-winter removal is due to adjustments among loss rates, and to adjustments between rates of recruitment and loss. Emigration was an important demographic influencing the effectiveness of control efforts.

Harvest

In Voight and Berg (1987) state that coyotes are most vulnerable to natural and human caused mortality during their first year so mortality rates must be calculated separately for juvenile and adult age classes. Human caused mortality (90% in some studies) is the major cause of death. Sex ratios of harvested populations were equal or slightly favoured males.

Carbyn (1982) found that as wolf densities declined as coyote densities increased. Coyote survival was greatest along wolf territory edges at moderate wolf densities and coyote death related to wolves were highest when wolf densities were greatest. Other authors report that wolves have been known to prey on coyotes (Banfield 1974).

Management Implications and Research Recommendations

In Voight and Berg (1987) the major research question, aside from those involved with improving control techniques, addressed the effectiveness of control measures and the response of coyote populations. The authors state a minimal goal in coyote studies to understand the effects of management activities on the coyote. In Hamlin *et al.* (1984 cited in Voight and Berg 1987) the distribution of clearcuts in space and time is important to maintain a diverse food resource for coyotes and the timing and the kind of treatment applied to clearcuts, especially as it affects the viability of plants, may have direct or indirect effects or coyote populations.

Researchers in Voight and Berg (1987) urged investigators to examine how coyotes used their home range and how use varied with behaviour, food abundance and distribution, vegetation and other factors.

The B.C. Wildlife Branch (1980) notes that problems involving coyote include lack of inventory data (new census techniques are necessary) and there has been little biological research on the coyote in B.C.

Enhancement of coyote populations is not considered needed since they are so adaptable and they can inhabit nearly all habitat types within the province (B.C. Wildlife Branch 1980). Currently, coyotes within B.C. are not known to depress other wildlife populations on a long term basis, and site specific management of coyote populations would be considered to restore balance between coyote and prey populations if problems occur. There are no accurate assessment of coyote populations throughout the province and there does no need for serious concern over the future of coyotes within the province.

9.2.7 Red Fox

The red fox is a small slender canid measuring between 90 and 120 cm and weighing from 3.6 to 6.8 kg with a large bushy tail. The red fox is polytypic as it has four colour phases which are classified as red, black, cross and silver phases. Foxes occur over most of B.C. except for the heavily forested western slopes of B.C.'s coastal mountains and has been successful in adapting to agricultural systems and has extended its range as farmlands have replaced heavier forests (MOE 1980). Important predators besides man are larger carnivores (coyote) and larger cats, a high reproductive potential and appears to have a large population turnover each year (Banfield, 1974).

Habitat Use and Preference

The red fox is described as utilizing edges, living in semi-open parkland habitat, and in uplands where open meadows are interspersed with groves (B.C. Wildlife Branch 1980). Red foxes adapt well to civilization, living in agricultural areas where farmlands alternate with woodlots, cut-over scrub, and meadows. The red fox also lives near lakeshores, river valleys and tundra (Banfield, 1974).

Theberge and Wedeles (1989) studied sympatric coyotes and red foxes cross the peak of snowshoe hare cycle, and found that species differed little from one another in prey selection and both were heavily dependent on hare. After the hare crash, however, foxes turned more to alternative prey than did coyotes. The authors suggested that foxes persist in this environment when hares are less numerous because of an ability to exploit alternative prey and foxes and coyotes differed in their selection of habitat patches and use of edge. Coyotes exploited edge, where hares were most abundant, and open communities while foxes showed no significant use of edge and used only brushy communities. The coexistence of red foxes and coyotes in the southwest Yukon may be facilitated by balancing competitive abilities: foxes persist because of elasticity in their choice of prey and coyotes persist by dominating edges. (Foxes probably avoided areas where coyotes were since coyotes will prey upon them.)

In Voight (1987) the worldwide distribution of foxes clearly indicates that the species can survive in a wide variety of habitats including mountainous settings, through boreal forest and into interior grasslands. In developed areas foxes are found in agricultural areas where woodlots are interspersed with croplands and grass pastureland and these areas provide an abundance of food and prey as well as denning areas. Competition with other canids and the availability of suitable year round food sources limit fox survival and habitat determines the availability of suitable year-round food resources and the presence and absence of other canids.

In Aubry (1984) found that the distribution of foxes was concentrated generally occupy subalpine meadow and parkland in open forests with understory less dense with dominant forest species such as grand fir and ponderosa pine. Open forests probably provide enough space for predators such as foxes to effectively fine prey . Denser forests with heavy undergrowth do not provide the same opportunities. In a summer study in northwest British Columbia, Jones and Theberge (1982) found that foxes selected habitats dominated by Salix shrub communities and avoided open lichen - Empetrum and fen communities. Selection of these communities correlated with the highest and lowest microtine densities which were one of the two principal foods of the foxes.

In White *et al.* (1980), fox populations are scattered but are found primarily in upper elevation forests associated with the Sierra Nevada Crest. Habitat preferences include use of mature pine and fir forests interspersed with meadows during the summer and mixed-conifer and ponderosa pine forests in winter. Special habitat requirements include rock outcrops, hollow stumps or logs, or deep, loose soil for den sites and forest openings.

Foxes may dig burrows, use an abandoned one, or live in a shallow cave, hollow tree, or dense brush. Usually it has several dens in close proximity for escape purposes. It uses dens year after year (Banfield, 1974).

Habitat Alterations/Impacts

It was not anticipated that habitat loss to these species will be an important factor during there term of this plan (B.C. Wildlife Branch 1980). Fox are adaptable to most changes in the habitat caused by man. In future, land use practices and habitat protection will be considered if warranted but habitat enhancement is currently not important at present considering fox numbers and available habitat.

General Biology

Food Habits

The red fox is omnivorous and tends to feed upon the most available food in an area with small mammals being the most important prey and include snowshoe hare, mice, squirrels, woodchucks *(Marmota monax)*, moles and muskrats (B.C. Wildlife Branch 1980). Carrion may also be an important part of the diet in some areas. In the summer, vegetation and various insects become important and are consumed in large quantities. Summer diets of foxes in northwest British Columbia and Southwest Yukon (Jones and Theberge 1983) consisted of primarily Artic Ground squirrels and voles and mice in the subalpine and alpine habitat while diets in the boreal forest, diets were dominated by snowshoe hares and a greater diversity of species. In Smits, Slough and Yasui (1989) microtinae (primarily varying lemming) were found to be the major prey species for red foxes in the summer as well as several bird species.

Voight (1987) describes the red fox as a nonspecific predator (one that forages on a variety of prey) and an efficient scavenger and in parts of North America (Ontario during the winter) carrion is important to the fox. Throughout most of the year, meadow voles *(Microtus pennsylvanicus)* are the major prey constituting at least 50% of the diet with some hare consumption. Fruits, berries and insects are sought during late summer and early fall and eggs and birds are eaten during spring and summer.

White *et al.* (1980) found foxes eat small rodents, ground squirrels, marmots, woodrats, rabbits, and insects. Foxes will also eat birds and berries when seasonally available and hunts during day and night.

Home Ranges

Summer home ranges averaged 1611 ha according to Jones and Theberge (1982). Home ranges may be shared by a mated pair or individuals
and home ranges average between 3.6 to 8 km^2 (Banfield, 1974) but vary according to prey density.

Voight (1987) found that the density of red fox populations is difficult to determine because of the animal's secretive and elusive nature. In northern boreal forests and the artic tundra, densities occur of 0.1 foxes/km^2. In small areas of the best habitat, three times as many foxes have been observed. Fox numbers can also change cyclically in some areas following the fluctuations in small mammals populations (voles) and where small mammal fluctuations don't occur and other prey are available, cycles don't exist. Home ranges (other than the Artic) are as great as 3400 ha and are 500 to 2000 ha in eastern farmlands.Home range sizes in the midwest of the U.S.A. varied from 130 to 2070 ha (White et al 1980).

Management Implications and Research Recommendations

Management is directed towards maintaining a resource within prescribed limits and regulating its use for the benefit of man (B.C. Wildlife Branch 1980). The B.C. Wildlife Branch objectives include maintaining populations at approximately existing levels over their present range and providing for the commercial use of fox through trapping. Harvesting at appropriate levels often improves their health and enhances the stability of their numbers and provides income for trappers and revenues from licences and royalties.

Management prescriptions for the Wildlife Branch include a good knowledge of the factors affecting fox is important as a basis for management. Since the behaviour of foxes makes it difficult to inventory, the B.C. Wildlife Branch recommends the development of indices which are responsive to annual population changes and are useful as a wildlife management tool. Factors that are related to fox numbers include food supplies, harvest levels, complaints of harassment or damage and field observations. Unless harvest increase dramatically or major declines in the populations are noticed, active management will not greatly increase. The branch recognizes the present use and priorities for fox and while they may not be those of the future, they will maintain the resource so that most options for management and use in the future will be available.

In Voight (1987), the author concludes that habitat destruction that reduces prey numbers will lower fox numbers to a greater extent than a short term overharvest (by trapping) will. High fecundity and the potential of foxes to disperse allow populations to withstand a high level of mortality and whether one year's excessive harvest would have any long-term effects is doubtful. The adaptability of foxes overrides the relatively small manipulations through management and only in local areas, where competitors such as coyote or disease such as rabies, population impacts are great and are relatively uncontrolled.

Voight (1987) summarizes the biggest gaps in fox knowledge as the contact rate among foxes (healthy or otherwise) in a population and its effect on the rate disease. Also, there is a need to better understand fox population dynamics. Methods to estimate population changes (and thus determine an allowable harvest) remain priorities. Red fox management has is more "exact" than other furbearers since many studies have been done improving the understanding of spatial and social behaviour of foxes. However, few studies to date have been completed in northern B.C.

In Voight (1987) the author suggests that if harvest levels must be monitored regularly if the effects of management alternatives are to be assessed.

9.2.8 Weasels

All information for weasels (both short-tailed and long-tailed) is from Fagerstone (1987). There was no distinction made between either short-tailed or long-tailed weasels on either harvest records or on trapper questionnaires and both ranges are within the Williston Lake watershed. The winter white fur of both the short-tailed and long-tailed weasel is known as ermine and many people do not distinguish between the two. Although, there are probably more actual ermine (short-tailed weasels) trapped, information is included for both.

General

All weasels are terrestrial hunters taking whatever small rodents, birds or other animals that are available locally and as with other furbearers, males and females have separate home ranges which may overlap with the range of a member of the opposite sex. Individuals are normally solitary and mortality is probably directly related to food supply but predation is also a factor. Few residents hold their home ranges for more than a year and are preyed on by raptors and mammalian predators such as domestic cats, coyotes, foxes and in the case of short-tailed weasels, long-tailed weasels.

Habitat Use and Preference

Long-tailed weasels appear to be restricted transition between aspen parkland and boreal forest. Boreal forest does not appear to contain the diversity of preferred prey and these weasels appear to be partially restricted to the vicinity of free standing water. The boreal forest does not contain the diversity of species preferred by long-tailed weasel and the long-tailed weasel is less abundant than the short-tailed weasel in areas of sympatry.

The short-tailed weasel is most abundant in boreal, montane and Pacific coast mountains. It appears to avoid dense forests, but settles in successional or forest-edge habitats, or riverbanks with high densities of small mammals. They are uncommon in pine-grown sand ridges and rolling uplands but common in lower spruce-aspen parklands, streamside coniferous belts and grassy, semiwooded swamplands.

Short-tailed weasels showed a preference for early successional communities such as grasslands and shrubs; in contrast long-tailed weasels showed a trend toward more advanced serai stages and were more general in their habitat preferences (62% overlap in habitat preferences Simms, 1979a cited by Fagerstone 1987). Where the two occur together, the long-tailed weasel occurs in more open habitats whereas the short-tailed weasel may be more common in forested habitats or wetlands.

The local distribution of short-tailed weasels is usually related to that of small rodents and lagomorphs and males cover a larger range of habitats and both males and females occupy more habitats during spring and early summer than during fall and winter. Long-tailed/short-tailed weasel nests are often in former rodent burrows or can be in a rock piles, crevice, or hollow logs.

Weasels are well adapted to snow and normally they travel on the surface of snow but to catch prey they may use runways constructed under the snow by mammals or burrow under the snow themselves. Their white colour probably helps camouflage against predators.

In White *et al.* (1980) short-tailed weasels are described as found at higher elevations in pine and fir forests. Short-tailed weasels prefer mature, dense timber for breeding and resting and meadows and other open areas for hunting. Long-tailed weasels are found throughout all habitats from foothills to grasslands to alpine meadows. Long-tailed weasels prefers meadows and other open areas, and young sapling stages of timber. Special habitat requirements for both are suitable den sites (ground cover, logs, stumps, snags, or burrows) and forest openings.

Fagerstone (1987) lists factors that cause variations in numbers including:

1) population densities of small prey,
2) climate (eg. snow depth, low temperatures),
3) habitat changes (flooding, drainage of marshes),
4) disease.

Prey densities are the most important for weasel management. When prey densities fluctuate, short-tailed weasels show population fluctuations that parallel those of their prey. So the effects of herbicides on small mammals can have significant effects on weasel prey populations.

General Biology

Food habits

Weasels are vole specialists with their diets consisting primarily (>50%) of voles followed by small mice. Shrews and cotton tails may be locally important dietary items and weasels hunt in habitats that voles inhabit. Short-tailed weasels feed more heavily on voles than long-tailed weasels but considerable overlap in diet occur a sites where both species are present. Long-tailed weasels are more of a generalist than the short-tailed relying on a variety of prey and will also take larger prey such as hares and squirrels.

In White *et al.* (1980) the major food of the short-tailed weasel is voles but they also eats mice, shrews and chipmunks (Tamias spp.). Weasels are described as small but agile predatory, searching for and pursuing prey in logs, stumps, dead wood, tunnels,and burrows. The prey of long-tailed weasels consists of voles, and mice with some use of chipmunks, woodrats, gophers, squirrels, some birds, insects, and vegetation. Both types of weasels are active all year and are diurnal and nocturnal. Short-tailed weasels can be cyclic patterned after a prey's population highs and lows.

Home Ranges

As for other furbearers, juveniles disperse in the fall. Male home ranges averaged 20-25 ha in Canada and female ranges averaged 10-15 ha. Home ranges vary in size according to habitat, prey abundance and the presence of other weasels and in good habitat with other weasels present, home ranges may be 4ha. Each weasel's home range contains several nests that are used as bases for hunting prey in that area before the animal moves on to another area.

Short-tailed weasel densities can reach 8 weasels/km2 at high point cycles and in good habitat, long-tailed weasel densities may be 1 weasel /km2 and may range as high as 7 weasels/km2 in favourable habitats (White *et al.* 1980).

During breeding season (spring and summer) males move extensively and during non-breeding seasons, males occupy less extensive areas and defend well defined territories while females rarely move out of their home ranges stay put.

Management Implications and Research Requirements

The ecology and behaviour of weasels are less well-known than that of other furbearers and additional research is needed in many areas. This includes particular emphasis on long-tern studies of demography and the dynamics of populations in different environments. Methods of estimating populations for proper assessment of an allowable harvest to be developed. More research needs to be conducted on the role of weasels in communities, including mechanisms that enable coexistence with other species. The behaviour of individuals needs more research, particularly foraging behaviour, activity patterns and home ranges as they relate to available resources.

Long-tailed weasels are earmarked for research since trends increase populations are steadily declining since 1930's in Canada. This is more related to urban and agricultural development especially in prairie provinces aspen parkland. Short-tailed weasels are also declining due to habitat loss though not as dramatically as long-tailed weasels.

Ecology and population studies are considered important research topics.

9.2.9 Wolf

Little information is available on wolf habitat requirements. Rather the information is based on the habitat requirements of prey species for wolves. Much of the recent publications in B.C. are based on wolf-prey dynamics; the following ecology based information is taken from Carbyn (1987).

In a review of the status and management of wolves in Canada (1984), in B.C. legal harvest seasons were open year round in most areas and partly closed in only a few. The population trend was considered stable to increasing and detailed research ongoing. Wolf behaviour is affected by reproductive cycle and the need to hunt in packs. Pack dynamics, social status of individuals, movements, and certain aspects of seasonal habitat use are all affected by the reproductive process. The greatest mortality factor for wolves is humans.

Habitat Use

Wolves are not restricted to specific habitats and the presence of wolves dictated by the availability of habitat for its prey species. Suitable denning habitat appears to of secondary importance and in forested areas, dens are generally found in elevated sites with good drainage within 500m of waterbodies. Other forms of dens can be rock crevices, beaver lodges, hollow logs and overturned stumps. The reuse of dens is common and many den sites are found in habitats dominated by trembling aspen stands. A wolf pack generally produces one litter per year and young are usually born in earth dens or in dens taken over from other animals.

Wolf population dynamics regulating pack size are mostly based on food availability and food availability is based partly on suitable habitat for prey species. Home ranges are variable with dispersed prey populations throughout the pack's territory.

Child and King (1988) state that a diverse and abundant prey base makes for healthy populations of wolves although the population is not considered excessive. Wolves exist in all habitats where food resources are suitable and the abundance of wolves may be regulated by the density of ungulates as potential food. Habitat not used by wolves, especially where ungulates occur, is usually due to human intervention (such as trapping, hunting and removal. Human activities that reduce ungulate populations can also impact wolf populations. At present, wolf populations are permitted to fluctuate as part of the ecosystem and opportunities exist to increase the supply of wolves dependent on an increase in ungulate populations.

Food Habits

Wolves are described as opportunistic feeders so when prey is most abundant, wolves prey on the most vulnerable animals. Snow conditions and forage limitations may render a large proportion of a prey population vulnerable to wolves.

Wolves are able to shift food habits (i.e. beavers during summer in northern areas, calves during ungulate calving seasons). Wolves will kill other carnivores such as coyotes and wolverines.

Management Implications/Research Recommendations

Carbyn (1987) suggests that more information is required on how quickly and efficiently wolves can switch from one prey to another and on how much variability exists among individual wolves and among wolf packs. Continued monitoring of wolf/prey populations is important to determine whether wolves are declining or increasing in response to prey levels and prey levels can be increasing or decreasing according to either habitat and/or predation. Carbyn suggests that designating the wolf as a furbearer provides adequate legal protection. More information is required on long-term implications of predator on prey and how this is influenced by other factors such as severe winter weather, behaviour of prey species over time and how in the absence of predation, these species may change and so forth. Carbyn suggests this lack of understanding raises important concerns about the effects of wolf control, what kind of research questions to ask, and how much effort must be expended on research.

Child and King (1988) target predator-prey relationships as needing investigation. Annual surveys should be established in several areas for wolves in order to determine population trends and predator-prey ratios necessary to develop management strategies.

The B.C. Wildlife Branch (Archibald 1979) feels that there has been an increase in the abundance of wolves in B.C. in the past 10 years. Management objectives for wolves in B.C are as follows:

1) maintain viable populations of wolves in wilderness areas,
2) provide opportunities for people to listen to and observe wolves in their natural habitat,

3) control wolves in established livestock management areas,
4) control wolves on a site specific basis where the main objective is to maintain another wildlife species at a desired level,
5) provide for the hunting and trapping use of wolves (wolves are classified as both big game and furbearer in B.C.).

Other reports concentrate more on the removal of wolves rather than ecology, such as habitat use.

Janz (1987) discusses the objectives of the Vancouver Island wolf control program as not only reducing wolf numbers on Vancouver Island to allow recovery of deer but also to ensure the continued existence of wolves, and the long-term maintenance of the predator-prey system. Trapping was the only proven methodology for wolf control in these types of habitats and the response and success of registered trappers were somewhat disappointing. Although there were several factors (ie poor pelt quality of marten), few trappers were willing to incur the transportation expenses associated with wolf trapping with little opportunity for financial returns.

Herbert (1987) in discussing wolf control in the Quesnel Highlands, points out that the Ministry of Environment would have difficulty justifying the retention of unlogged caribou habitat if, due to wolf predation, caribou cannot use or under utilize the habitat currently being reserved from logging. The author states that wolves can actively prey on caribou calves and that moose have been implicated in the demise of caribou elsewhere in North America (providing an alternate food source that allows wolf populations to increase in caribou ranges). Wolves will be reduced but not eliminated from the area and information will allow long-term management program for wolves, caribou and moose to be designed.

In northern British Columbia, wolves are linked to fluctuations in caribou herds (Bergerud and Elliot 1986). In areas where wolf numbers were decreased, caribou calf survival in creased. In other populations, where no wolf control was implemented, caribou populations declined as a result of predation on calves and adults. The authors believe it is possible to manage wolf numbers so that caribou herds will maintain recruitment to balance adult losses and dampen the natural fluctuations of wolves and caribou and maintain higher numbers of each. The authors also point out that moose range expansion into the north provided a prey source so wolves numbers increased and predation on caribou resulted.

9.3 Interviews with Wildlife and Forestry Resource Managers

9.3.1 Interviews With Wildlife Resource Managers and Furbearer Experts

Interviews with wildlife resource managers indicated the following points:

Research should go into developing better inventory systems for furbearers. These systems could be innovative (i.e. using remote cameras) and should be cost effective. Inventory techniques should be related to habitat. Fisher, wolverine, lynx and marten need reliable inventories and additionally, research should also be focused on lynx denning habitat, forestry impacts, and impacts on snowshoe hare habitat. Marten have been thoroughly researched and it is now considered the 'time' to try out habitat suitability index models. Any sort of research should be adequately monitored and 'followed up' on.

Research should also be focused on using graduate students and should be cooperative ventures with universities such as UNBC.

The development of handbooks or specific guidelines on how to manage habitat to meet furbearer needs for use by both forestry and other resource personnel was considered extremely important. This type of approach would promote integrated resource management and at least all parties would have the same information base to work from.

Developing a cooperative management plan between the trappers and the government would be a useful tool. These plans could be shown to foresters as part of the planing process that foresters could look at for integrated management. It would be up to Victoria to do an outline for cooperative management program. If these plans/maps were incorporated in the GIS system, foresters could overlay on company maps to see potential problems.

Forest companies to should explain what/why they're doing in a 'trapper's language' rather than technical terms. Forest service should enforce the terms of contracts (i.e. for brushing and weeding) more to see terms of the contract are being met and more habitat than necessary be impacted.

Wolverine need more research into habitat use and population assessment.
Lynx also requires more research into the lynx/hare cycle. This would allow closing of the season during the low cycles and possibly permit trappers to trap just before an anticipated low (so animals that would die anyway can be taken). Also trapping at a low cycle impacts recruitment so a better understanding of the whole cycle is needed specific to the region.

Wolves need more impact assessments since they are heavily dependent on ungulates and reduce numbers especially in the winter when lack of winter range/snow conditions are already limiting to ungulates. Trapping is way to control wolves.

Interviews with other parties with pertinent information included an assessment vary similar to the trapper questionnaire. Access (from developing road systems) was seen as very real problem.

Habitat requirement research and how this translated into population increases and decreases was also highlighted as an issue of concern. The role of education was also brought up many parties dealing with furbearer habitat would know exactly what they were affecting. Furbearer priorities were similar to those found through the questionnaires.

Other specific comments included:

"Fisher populations were not traditionally high because there is not much of their required habitat (mixed deciduous- conifer) around."

"Lynx were never traditionally high because of lack of habitat and the habitat occurs in 'little pockets' that aren't connected."

"Wolverine are important topic of research due the disturbance of their traditional habitats. Wolverine numbers are about 10% of what they used to be. Trap experience is an important part of wolverine survival. With the new (humane) traps, wolverine are killed instantly and do not learn to avoid traps. Previously, a wolverine may lose only a toe in a trap and that teaches them to cautious."

"Don't trap after the end of December for marten in order to increase fisher numbers."

"It would take an area of 800-1000 mi ^{2} for a trapper to make a living commercially while a recreational trapper only requires 50-100 mi ^{2}

" Specific to marten the current cut block sizes are devastating and there should be smaller size cut blocks with better interspersion. The loss of martens should be minimized i.e. currently when 40% of an area is logged, 80% of the marten are lost; this should be decreased to losing only 40% marten loss. Long-term management is required to create better marten habitat in the future . Marten need a variety of trees (including snags and blowdown) and good marten habitat is not a uniform stand."

9.3.2 Interviews With Forestry Resource Managers

Interviews with forestry industry personnel indicated the following points:

Specific guidelines or well-defined goals are required to help forest service planning. Admittedly, there is a lack of understanding from a forestry perspective (i.e. lynx cycles are not clearly understood) but formulating guidelines or handbooks where a forester can look up specific management prescriptions (ie. how much CWD should be left in a clearcut) would be useful guidelines. Although it is difficult to do practical interpretations of "biology", any sort of guideline is better than nothing or just vague management options.

Research into creating furbearer habitat requirements in second-growth forests was considered a priority. Although leaving blocks of timber will help maintain furbearer habitat, it was considered only a short-term solution. Since the amount of habitat in successional stands is increasing, methods and knowledge on how to recreate specific habitat characteristics into second-growth stands seemed a feasible approach.

Another topic was to relate population numbers to habitat. Foresters wanted to know how many animals they are managing for and what the carrying capacity of different types of habitats are.

Try to tailor these management guidelines (e.g. how much CWD to leave) to ecological associations and tree species. Also in terms of cutblock, volume limits are more important, from a management perspective, than size.

Alternative harvesting systems were discussed but clearcutting is still the most dominant practice.

Guidelines should be specific for these areas and management should be focused to creating diverse successional stages (Note: Only some foresters agreed with this.)

In terms of silviculture, if trappers would produce a map showing where their high value trapping areas are would at least help in the planning process.

Communication and coordination should be improved between everyone concerned. For example, the forest service and a forest company may end up applying herbicides to adjacent blocks at the same time instead of staggered times. Trappers are difficult to get hold of and often don;t respond. Lack of people to oversee contractors (who can get overzealous when brushing and weeding stands) is a problem.

Planning objectives should be well-defined in at all levels. If there are concerns for furbearers they should be addressed.

Research into alternative forestry practices to enhance habitat and enhance forestry values is important. Innovative techniques are being tried. For example, a type of machine is being used to chip up debris to add nutrients to the soil in site preparation. If piles of debris are left for furbearer use, this type of approach would be more beneficial than burning a site.

The bark beetle problem may increase intensive management of stands to produce so the effects of intensive silviculture on furbearers should be thoroughly researched.

9.4 Results and Comments of Trapper Questionnaire

9.4.1 Covering Letter and Trapper Questionnaire

DQB Consultant
Box 1372,
Mackenzie.B.C. VOJ 2CO
September 21, 1992.

Dear Trapper,

The Williston Wildlife Compensation Program is coordinating a long-term upland furbearer program for the Williston Lake watershed. I, Dana Becker (an independent wildlife biologist), am working as a contractor to put together an "Upland Furbearer Problem Analysis" which will help direct priorities of research, enhancement, and integrated management for upland furbearers in the Williston Lake watershed. To development a sound and comprehensive long-term upland furbearer program, information from trappers is urgently needed.

Attached is a questionnaire dealing with furbearers in the Williston watershed. As a trapper, you deal with many of these species on a direct level. You know how often you catch certain species, where these species are found, if logging an area or using herbicides or other forestry activities effect the occurrence of animals in the area you trap and general population trends. In developing this questionnaire, I consulted with Chico Crossland (President of the Mackenzie Trappers Association) as to whether the questions made sense and would be useful for both the information I required and your input.

Although you have been sent questionnaires before, this particular surveys deals only with the Williston Lake watershed. Answering this questionnaire will help to determine where research and enhancement opportunities will be directed in the Williston Lake watershed. Although, it would have been preferable for me to visit with each of you, time constraints make this impossible. The only way to reach everyone that has a trapline in the Williston Lake watershed was to send out this questionnaire. If it is easier, trappers in one area can get together as a group and just fill out one form (but remember to put each person's name on it). If you only want to answer certain questions that's fine because any information is useful. If you need further space to answer questions then attach an extra sheet and put down the number of the question you are answering. If you have further comments or thoughts regarding furbearers in the Williston Lake watershed please contact Dana Becker at 997-6399 or Box 1372, Mackenzie, B.C. VOJ 2CO.

Please return the questionnaire by September 30, 1992 at the latest. Thanks for all your time and effort.

Sincerely,

Dana Becker
DQB Consultants

Questionnaire For Trappers in Williston Lake watershed
Upland Furbearer Problem Analysis

Species under consideration (as outlined by Williston Wildlife Compensation Program) are:

Marten	Wolf	Lynx	Coyote
Fisher	Wolverine	Fox	Weasel

1. How would you personally describe the population of each of the following species in your area and do you feel that any of these species are decreasing or increasing in population numbers in your area over the past few years? (Please mark response with an "X".)

Current Population

Marten
__ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Marten
__ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ____________________

Current Population

Lynx
__ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Lynx
__ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ____________________

Current Population

Fisher
__ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Fisher
__ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ____________________

Current Population

Wolverine __ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Wolverine __ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ______________________________

Current Population

Wolf __ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Wolf __ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ______________________________

Current Population

Coyote __ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Coyote __ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ______________________________

Current Population

Fox __ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Fox __ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ______________________________

Current Population

Weasel __ extremely scarce
__ scarce
__ common
__ plentiful
__ extremely plentiful
__ don't know
__ not present

Population Changes

Weasel __ rapidly decreasing
__ slowly decreasing
__ no change
__ slowly increasing
__ rapidly increasing
__ don't know

Comments: ____________________

7. If population numbers of these species are decreasing/increasing is it because of:
   - A. Habitat changes
   - B. Lack of prey
   - C. Abundance of prey
   - D. Lack of prey due to habitat changes
   - E. Lack of prey (overpredation) and habitat changes
   - F. Overharvesting of certain species
   - G. Weather (For example: severe or mild winters)
   - H. Predation (other than man)
   - I. Too many of one species (crowding, competition)
   - J. Natural population cycles
   - K. Other (please describe)

Please put down the letters indicating your responses beside each of the species and any comments you may have.

Marten ____________________

Fisher ____________________

Wolf ____________________

Lynx ____________________

Coyote ____________________

Fox ____________________

Weasel

Wolverine

3. Could you please list the numbers of each species you trapped/shot each year from 1986 to 1991/92. This includes animals that you sold to fur traders, sold privately, used for making clothing articles and so forth. (This is strictly confidential and will provide more information in terms of population numbers.) Seasons are divided by a slash indicating what part of the year the season began in.

	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
Marten						
Fisher						
Lynx						
Wolf						
Coyote						
Fox						
Weasel						
Wolverine						

4. What time of the year do you trap certain animals and why do you trap certain species (other than seasonal regulations) when you do?

For example, some trappers trap marten between November 1 to November 30 because the pelt is in the best condition at that time of year and the best price can be received. Other trappers are unable to trap marten until later on in the year because they can't reach their traplines (i.e they have to wait for the lakes to become frozen so they can cross to inaccessible areas and so forth).

Time of Year Trapped and Reasons

Marten

Fisher

Wolf

Lynx ____________________

Coyote ____________________

Fox ____________________

Weasel ____________________

Wolverine ____________________

5. Do you believe that research/enhancement should just concentrate on a few representative species? For example, if you manage for wolverines than every other species should be present in sufficient numbers or should all of these species be managed for individually? (Please mark your answer and add comments if you wish.)

Yes __ No __ No Opinion __
Comments: ____________________

6. What species seem to require the most habitat diversity (different types) and which require the fewest? Are there any species that survive in just one habitat type?

	Require Habitat Diversity			Amount of Diversity		
Marten	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Fisher	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Lynx	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Wolf	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Coyote	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Fox	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Weasel	Yes__	No__	Don't Know__	Lots__	Some__	Little__
Wolverine	Yes__	No__	Don't Know__	Lots__	Some__	Little__

Please indicate which species you feel should have the highest priority concerns for research in your area by numbering the listed species 1 (lowest) through to 8 (highest) below and adding any comments you may have.

Marten

Fisher

Wolf

Lynx

Coyote

Fox

Weasel

Wolverine

8. Please indicate which species you feel should have the highest priority concerns for enhancement in your area by numbering the listed species 1 (lowest) through to 8 (highest) below and any comments you may have.

Marten

Fisher

Wolf

Lynx

Coyote ____________________

Fox ____________________

Weasel ____________________

Wolverine ____________________

9. Do you think there are too many traplines in your particular area (i.e. should there be fewer traplines in one geographic area)? (Please mark your answer and add comments if you wish.)

Yes __ No __ No Opinion __

Comments: ____________________

10. Certain species should not be trapped over the next few seasons to help build up population levels but often this is impossible to do. For example, even though you are setting traps for marten, you often catch fisher -> a species that is currently closed for trapping due to low population numbers. What species do you think should not be trapped over the next few seasons to build up population levels and how would you accomplish this considering the problems involved?

Marten	Yes __	No __	No Opinion __
Fisher	Yes __	No __	No Opinion __
Wolf	Yes __	No __	No Opinion __
Lynx	Yes __	No __	No Opinion __
Coyote	Yes __	No __	No Opinion __
Fox	Yes __	No __	No Opinion __
Weasel	Yes __	No __	No Opinion __
Wolverine	Yes __	No __	No Opinion __

Comments: ____________________

11. Should only trappers with valid licences and native indians be allowed to purchase traps to decrease illegal harvest by unlicensed trappers? (Please mark your answer and add comments if you wish.)

Yes __ No __ No Opinion __

Comments: ____

12. Would you be willing to develop a cooperative management plan for your trapline? Would you like to see more research and development put into this approach where habitat/population research with your cooperation and input would help you more effectively manage your own trapline? (Please mark your answer and add comments if you wish.)

Yes __ No __ No Opinion __

Comments: ____

13. Do you think there should be better communication between the forest companies and trappers? Although trappers are consulted during the initial phase of the 5 year development plans, often changes are made to the plan without consulting with the trapper (or not being able to contact him/her for a period of time) and the trapper loses traps he/she may have left in the forests for next year's trapping, loses trapping habitat etc.

Yes __ No __ No Opinion __

Comments: ____

14. Would you be willing to volunteer your time to help enhance habitat for furbearers?

Yes __ No __ No Opinion __

Comments: ____

15. Rapid changes are taking place in the forest throughout many areas. Please indicate (yes or no) whether a practice seems to affect each the furbearers found in your area terms of habitat loss. If possible, could you please rank on a scale of 1 (lowest) to 9 (highest) what practices seems to affect furbearer habitat the most. If you can think of any other land management practices that affect furbearers that aren't mentioned please elaborate on the lines following this question.

	Yes	No	Rank
Logging/harvesting	__	__	____
Silviculture practices such as thinning and pruning	__	__	____
Forest herbicides	__	__	____
Mining	__	__	____
Road building	__	__	____
B.C. Hydro lines	__	__	____
Flooding	__	__	____
More people living in the area	__	__	____
Forest fires	__	__	____

Other: ____

16. What type of habitat (forest type and successional stage) do you most often find each of these species in? Forest habitat types (actually known as biogeoclimatic zones since they result from several influences including climate) and successional stage descriptions are listed below. When answering for each species please indicate which habitat and successional stage are used the most and if possible, any other habitats that you find species in occasionally.

For example, marten are most often found in SBS (sub-boreal spruce zone) in climax forests but are occasionally found in young timber. So the answer would say that marten are found in the climax stages of SBS most often but are occasional found in young timber in the SBS.

This is a difficult question to ask since certain animals may sleep in one habitat type and feed in another. This is a very research oriented question and please try to fill in as much information as you can.

Marten

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Fisher

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Lynx

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Wolf

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Coyote

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Weasel

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Fox

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

Wolverine

Most used habitat type/successional stage (and possible activities).

Other habitats and successional stages used.

17. There are many ways to solve different problems in managing furbearer habitat and everyone has different ideas. For example, some trappers suggest that applying herbicides in a "hack and squirt" method (where undesirable trees are hacked with an axe then have herbicide applied to eventually kill the tree) is a preferred method rather than broadcast spraying an area. Other concerns involve the amount of debris left on the ground after clearcutting. Debris is important for many furbearers as denning areas, hiding cover and so forth but many people think the amount of debris left over is too much. What other ideas and thoughts do you have on habitat management problems?

For example logging concerns may include:
  - types of logging practices you would like to see and why (more/less clearcutting, smaller clearcuts, selective logging, horselogging etc.)
  - amounts of debris left over, whether snags should be left for birds as furbearers etc.

As you can see, there are many different areas that can be addressed (and it's impossible to list them all) so feel free to elaborate on any issue. Some categories have been listed as suggestions below.

1. Logging/harvesting
2. Silviculture practices such as thinning and pruning
3. Forest herbicides
4. Mining
5. Road building
6. B.C. Hydro lines
7. Flooding
8. More people living in the area
9. Forest fires

Optional Question: (Don't answer if you don't want.)

18. Some of the questions aren't asking what you think is important for furbearer research and often it's difficult to phrase a question to get the information required. For example, it is important to know how much time and effort it takes to trap certain animals. But all sorts of variables are involved included how often you check traps, whether you have to replace traps even though nothing is in them, weather conditions, another animal eating your trapped animal and so forth. How would you word questions to get these types of answers or how would you word any of the previous questions? Note often questions are asked in the way they are to get answers that can be summarized -> 68% answered yes to a certain question. How would you do this type of survey?

9.4.2 Results and Comments by Question

Note: Comments shown in quotation marks are taken directly from trappers personal comments on the questionnaire. No grammatical or spelling corrections have been made.

Question 1 dealt with the current populations and possible population changes for each furbearer on a species basis. Of the trappers surveyed, the following results were obtained and summarized as percentages:

Marten

Current Population

0% extremely scarce
4% scarce
48% common
35% plentiful
9% extremely plentiful
0% don't know
4% not present/applicable

Population Changes

13% rapidly decreasing
43% slowly decreasing
30% no change
9% slowly increasing
0% rapidly increasing
4% don't know

Comments: Trappers were mainly concerned with logging practices causing habitat destruction. Many indicated that the marten was "once plentiful but is rapidly disappearing along with the timber". One trapper noted that "after 20 years of logging on my line, marten are down to about 1/3 of previous numbers. My average harvest is 50 to 70 per year where it used to be 150 to 250".

Lynx

Current Population

17% extremely scarce
52% scarce
13% common
0% plentiful
0% extremely plentiful
4% don't know
13% not present/applicable

Population Changes

4% rapidly decreasing
35% slowly decreasing
26% no change
17% slowly increasing
0% rapidly increasing
17% don't know

Comments: Trappers indicated either the trapper's area did not have the right habitat for lynx or that silvicultural activities (herbicides, brushing, and weeding) eliminate lynx/hare use of an area due to habitat alterations. Some noted " we are in a cycle peak".

Fisher

Current Population

Population Changes

48% extremely scarce
30% scarce
4% common
0% plentiful
0% extremely plentiful
0% don't know
17% not present/applicable

17% rapidly decreasing
26% slowly decreasing
30% no change
0% slowly increasing
0% rapidly increasing
26% don't know

Comments: Most trappers indicated that fisher are scarce. One trapper stated "never was good fisher since we knew it (winter 1937/38)". Opinions were varied on the reasons for fisher decline: either Overharvesting, logging or a combination of both. One trapper sees fisher tracks regularly and avoids trapping them. Note: this could be a good area for research.

Wolverine

Current Population

4% extremely scarce
65% scarce
22% common
4% plentiful
0% extremely plentiful
0% don't know
4% not present/applicable

Population Changes

0% rapidly decreasing
35% slowly decreasing
52% no change
4% slowly increasing
0% rapidly increasing
9% don't know

Comments: Wolverines are considered scarce by most trappers and note that wolverine numbers are declining. One trapper mentioned that in "some winters there are 4-5 wolverines and others, there is only 1-2. I believe that depends on snow, temperature and available food".

Wolf

Current Population

0% extremely scarce
43% scarce
26% common
22% plentiful
4% extremely plentiful
0% don't know
4% not present/applicable

Population Changes

9% rapidly decreasing
13% slowly decreasing
48% no change
13% slowly increasing
4% rapidly increasing
13% don't know

Comments: The general feeling was that wolf numbers were declining for a variety of reasons including, lack of prey (big game being overharvested or wolves and bears decreasing the prey stock) or overhunting. Some trappers thought that wolf numbers were about the same but could decline based on climatic conditions and prey populations.

Coyote

Current Population	Population Changes
4% extremely scarce	0% rapidly decreasing
39% scarce	4% slowly decreasing
17% common	52% no change
26% plentiful	30% slowly increasing
0% extremely plentiful	0% rapidly increasing
4% don't know	13% don't know
9% not present/applicable	

Comments: The general impression was that coyotes were never common but their numbers may be increasing because of greater prey availability (mice in clearcuts).

Fox

Current Population	Population Changes
17% extremely scarce	0% rapidly decreasing
22% scarce	13% slowly decreasing
48% common	57% no change
9% plentiful	22% slowly increasing
0% extremely plentiful	0% rapidly increasing
0% don't know	8% don't know
4% not present/applicable	

Comments: There were a range of comments concerning fox. Some trappers indicated foxes are available periodically but not in large numbers. One trapper mentioned that foxes occurred mainly around clearcuts and another indicated that fox are plentiful since logging has improved the mice population. Another trapper wrote that fox populations go down as coyotes increase, while a third stated that fox are "not present" in the Ospika watershed.

Weasels

Current Population	Population Changes
4% extremely scarce	0% rapidly decreasing
17% scarce	8% slowly decreasing
48% common	57% no change
22% plentiful	26% slowly increasing
0% extremely plentiful	0% rapidly increasing
4% don't know	8% don't know
4% not present/applicable	

Comments: There were very few comments on weasels and most dealt with weasel dependency on mice availability. One trapper mentioned the marten " are hard on weasels".

Question 2 was based on reasons for population changes (if any) and trappers were given several categories in which to respond. Many trappers had already answered this question in their comments for question #1.

Marten Habitat changes - 52%
Lack of prey - 4%
Lack of prey due to habitat changes - 22%
Overharvesting of certain species - 4%
Weather - 4%

Most comments referred to habitat changes being the major force affecting marten. Specifically logging and the creation of large clearcuts as well as silvicultural practices identified as being detrimental . One trapper stated "Every square mile of heavy forest can easily support four breeding (pairs or females). When this home is removed so are the marten. If they return after the loggers leave they are immediately eaten by owls".

Fisher Habitat changes - 30%
Lack of prey - 4%
Lack of prey due to habitat changes - 17%
Lack of prey (overpredation) and habitat changes - 4%
Weather - 4%
Natural population cycles - 9%

Habitat changes through logging and lack of knowledge about fisher be trappers were noted as problems.

Wolf Habitat changes - 4%
Lack of prey - 4%
Abundance of prey - 4%
Lack of prey due to habitat changes - 4%
Lack of prey (overpredation) and habitat changes - 4%
Weather - 4%
Natural population cycles - 9%

No comments.

Lynx Habitat changes - 22%
Abundance of prey - 4%
Lack of prey due to habitat changes - 9%
Weather - 4%
Natural population cycles - 30%

Many comments involved the lynx/hare cycle as the reason for population increases/decreases. Forest practices such as herbicide use were considered to be detrimental to hare habitat and fire suppression was considered to help develop hare habitat. Some trappers noted that a lot of habitat in the Williston Lake watershed is not appropriate for lynx.

Coyote Habitat changes - 4%
Lack of prey - 4%
Abundance of prey - 9%
Weather - 9%
Predation (other than man) - 4%
Natural population cycles - 4%

Coyotes are either increasing or decreasing dependent on: "Milder winters, garbage dumps, gut piles from Indians and white poaching and lighter snow falls have helped Mr. Coyote", or "Predation due to the wolf population".

Fox Habitat changes - 8%
Lack of prey - 4%
Abundance of prey - 13%
Weather - 9%
Natural population cycles - 4%

Weasel Habitat changes - 0%
Abundance of prey - 9%
Lack of prey (overpredation) and habitat changes - 4%
Weather - 4%
Natural population cycles - 9%

Weasels aren't trapped often because of their low fur prices. Few trappers had comments.

Wolverine Habitat changes - 13%
Lack of prey - 4%
Overharvesting of certain species - 4%
Weather - 4%
Natural population cycles - 4%

Due to the scarcity of the wolverine many trappers had difficulty commenting.

Question 3 was asked to see if there were differences between harvest records (kept by government) and actual numbers of animals being trapped. For example, several trappers indicated that they sold pelts (i.e. wolf and wolverine) privately therefore these would not be counted in harvest records. Other trappers utilize hides for personal use such as making items of clothing. Each trapper was asked to list the numbers of each species they trapped/shot each year from 1986 to 1991/92.

In general, most harvest records for marten were reasonably close to the actual number harvested. There were more discrepancies in the harvests for larger furbearers.

Question 4's purpose was to ascertain the time of year that trappers harvest certain animals (aside from regulations) and why certain species were trapped when they were. Responses to this question also gave an idea of the effort it takes to trap certain species.

Marten: November and December were the best months because the fur is in the best shape, the price is best and it is easier to get to the trapline since the deep snow has yet arrived.

Fisher: Most trappers do not trap fisher but they stated the best time is the early winter due to access and pelt quality.

Wolf: Not all trappers go after wolves but most of those that do get them from early winter to February after marten trapping is complete.

Lynx: Some trappers said December and January are best because of fur quality, while others try to trap lynx all season long.

Coyote: Not all trappers trap coyotes, but those that do, trap them from November to February.

Fox: The trappers that trap fox catch them from November to February.

Weasel: Trappers reported that weasels are easily trapped from November to February.

Wolverine: November to January is the best time to catch wolverine because of pelt quality and access to trap lines.

Question 5 asked the trappers if they believe that research and/or enhancement should just concentrate on a few representative species.

Yes 22% No 35% No Opinion 43%

Comments:" I believe all species must be properly manages but that marten deserve the closest scrutiny".
" Marten and wolverine depend on old growth spruce and balsam stands to survive. I believe the other species are more resilient to adverse changes in habitat. Managing marten also manages wolverine ".
"I do not think that it would be possible to work such a plan. Marten are depressing juvenile hare numbers and this is reflected in depressed lynx numbers. Marten appear to survive on voles and flying squirrels but not adult rabbits. There was no sign of red squirrel remains in gutted marten carcasses ".
"All species should be managed singly. Some together because of same food species".
"I believe research, enhancement for martens, wolverines, and weasels, would be fine as lynx, coyote, and fox are secondary species in my area".
"To ensure all species remain plentiful and to assure the public no animal is endangered".

Question 6 was omitted due to confusion with answers. The question intended to find out which furbearer used the greatest number of habitats or required the greatest habitat diversity. Many trappers were unclear on what was being asked and the answers were very confusing.

Question 7 asked the trappers to indicate which species they felt should have the highest priority concerns for research by numbering the listed species 1 (lowest) through to 8 (highest) below and adding any comments they had.

The answers were averaged out to derive a relative ranking. Comments (representing the main concerns of trappers) were included.

Marten 7.5
Deserves the most intensive work because it is the one very valuable furbearer we still have in substantial numbers".
"As long as we can retain habitat, marten is our main furbearer".

Fisher 5.4
"Because they are rare and trapping and lack of habitat is the reason".

Wolf 3.2
"Wolf will always be here in adequate numbers"
"No problem with this species, they adapt easy to the changes".
"They don"t need any more study".

Lynx 4.6
"Would like to see more in area".

"Because their numbers are down to years back and show no sign of cycling high again".

Coyote 2.6

"Coyote will always be here in adequate numbers".
"Will always hold their own".

Fox 3.3
"Fox will be here in the numbers this environment will support. Fox is primarily an open country, sand hill animal, and remains fairly constant in numbers".

Weasel 2.8
"Weasels don't seem to have many problems".
"I don't see that weasels are endangered in any way".

Wolverine 6.5
"Because they are not plentiful anywhere and have to be very closely managed".
"Wolverine is a conundrum for any manager. Here is a primarily mountain animal, i.e. Revelstoke yet it occurs high up on the arctic tundra".

Question 8 was the same as #7 but focused on enhancement priorities. As per above, answers were averaged out and certain comments were included.

Marten 7.5
"Logging practices have to change".
"Have lots of marten but overlogging could hurt them".

Fisher 6.9
"Not very many of them around".

Wolf 4.5
"Increase the moose you will see more wolves".

Lynx 5.8
"Need to know more about them".
"Need better habitat".

Coyote 3.0
"These are more adaptable to man's changes".

Fox 3.5

Weasel 2.6

Wolverine 6.3
"Not enough is know about them".
"Logging scares me".

Question 9 asked trappers if they thought there were too many traplines in their particular area (i.e. should there be fewer traplines in one geographic area) ? The aim was to determine how trappers felt about trapline size.

Yes 23% No 61% No Opinion 16%

Comments: "No, good trapline management maintains healthy populations. Some traplines may be too small but the majority are good sizes. I believe at the current market conditions it's hard to make a living anywhere even on large traplines".
"No, but there should be areas not trapped so such species as fisher and lynx could increase".
"Yes, traplines too small to earn an income lead to over trapping. Hobby trapping is another matter".

Question 10 wanted trappers to indicate which species should not be trapped over the next few seasons to help build up population levels.

Marten	Yes 13%	No 17%	No Opinion 70%
Fisher	Yes 26%	No 26%	No Opinion 48%
Wolf	Yes 13%	No 17%	No Opinion 70%

Lynx	Yes 17%	No 22%	No Opinion 61%
Coyote	Yes 13%	No 17%	No Opinion 70%
Fox	Yes 9%	No 17%	No Opinion 74%
Weasel	Yes 4%	No 17%	No Opinion 79%
Wolverine	Yes 17%	No 26%	No Opinion 57%

Comments: One trapper suggested that lynx and wolverine be closed on the same basis as the present fisher regulation. He also said the trapper should not be persecuted if he catches one and should be able to get a free permit. Another said he find no reason to have anyone or organization decide what or how much each trapper can harvest. A responsible fur harvester will only do what is right for the trapline. Doing otherwise is not to his benefit. A blanket policy on one particular furbearer is not the answer. A third trapper suggested a closure on wolverine but did not believe trapping has made them scarce.

Question 11 asked the trapper's opinion on whether only trappers with valid licences and native indians should be allowed to purchase traps.

Yes 65%   No 22% No Opinion 13%

Comments: "Yes, very definitely and the trap dealer should have to see and keep a record of each trappers' licence number who purchases traps".
"No, all natives are not trappers, by a long shot, private land owners should be able to get their problem animals".
"Yes, illegal trapping is hard to police, I think each trapper would look after his own line. Some checks could be made on logging operations, some loggers do set traps while living in the bush".
"Yes, if they can't but traps they can't poach".

3.2.12 This question was asked to see if trappers wanted more research and development put into an approach where they could effectively manage their own trapline.

Yes 56%   No 22% No Opinion 22%

Comments: "Yes, as a trapper I don't have all the biological data

concerning the line. Professional help would definitely have a positive effect but quotas and shutdowns should ultimately be the trappers decision".
"No, we already have a management plan, what we need is for the logging people to cooperate or back off".
"Yes, good idea, it's about time".
"Yes, more input from trappers could help".

Question 13 was another opinion question that was of concern to trappers. Many trappers were concerned about integrated planning and each was asked if there should be better communication between the forest companies and trappers.

Yes 80% No 10% No Opinion 10%

Comments: "Yes, the forest industry concerns itself almost wholly with growing and harvesting marketable fibre. Wildlife often becomes an after thought or no thought at all. We do get some minor concessions from forestry but the overall picture has changed little".
"Yes, we do have a good relationship with the logging company in our area".
"No, there is no use working with logging as they do as they please anyway".

Question 14 asked if the trappers would be willing to volunteer their time to help enhance habitat for furbearers and help the WWCP.

Yes 74% No 13% No Opinion 13%

Comments: "Yes, economic factors make it hard to commit too much time but I'm sure space can be made for a worthwhile project".
"Yes, I do it quite often be making brush piles for mice and rabbits to hide and feed. Also plant grass seed".
"No, I do enough for game and wildlife and I have time for no more".
"Yes, we have been doing it on our own for years and would love some help".

Question 15 asked trappers to indicate which habitat changes affected their trapping areas and to rank the changes on a scale of 1 (lowest) to 9 (highest).

	Yes	No	Rank
Logging/harvesting	74%	0%	6.8
Silviculture practices i.e.thinning and pruning	52%	13%	4.5
Forest herbicides	61%	4%	6.3
Mining	35%	35%	4.5
Road building	52%	9%	4.3
B.C. Hydro lines	43%	22%	3.7
Flooding	43%	26%	3.8
More people living in the area	39%	22%	3.0
Forest fires	48%	26%	4.8

Other: "Forest fires generally enhance, especially over the long term. It is the MOF efforts to put them out and to replant that destroys most of these benefits".
"Logging and road building are the worst by far".

Question 16 was one of the most difficult asked. The intention was to identify the habitats where trappers found and trapped furbearers. Unfortunately it was difficult for many trappers as they had not dealt with these concepts.

Marten
Most used habitat type/successional stage (and possible activities).
ESSF and SBS 5

Other habitats and successional stages used:
"Marten live in high valleys, along creeks with thick long spruce mixed with spruce and willows and often live around thick small pine to spruce for rabbits and when living up high you'd find them around thick small balsam and spruce".

Fisher
Most used habitat type/successional stage (and possible activities).
ESSF and SBS 5

Other habitats and successional stages used.
"Fisher are almost like martens, like to live in thick long spruce and pines and along creeks and around lakes where their is small thick pine, spruce, and willows for rabbits and chickens. In summer they like to live in the mountains for marmots and porcupines".

Lynx

Most used habitat type/successional stage (and possible activities).
ESSF, SBS, and SWB 3

Other habitats and successional stages used.
"Lynx live in young growth thickets where rabbits live. Mixed forests with uneven classes best".

Wolf
Most used habitat type/successional stage (and possible activities).
ESSF-SBS-SWB 3-4

Other habitats and successional stages used.
"Wolf follow their food, not the habitat".

Wolverine
Most used habitat type/successional stage (and possible activities).
ESSF-SBS 4-5

Other habitats and successional stages used.
"Wolverine use both alpine and low levels summer and winter. Need very large areas. Does well in remote areas, where there are people you have no wolverines".

Question 17 asked trappers to provide ideas and suggestions for solving habitat issues in the management of upland furbearers. A few representative comments are included.

" I believe it is unwise and unrealistic to expect the forest companies to carry out, either horse logging or selective cutting to any degree. Clearcuts could be smaller i.e. limit 80 hectares. After logging a good, wide smooth fireguard should be cleared around that portion of the perimeter bordering old growth to allow the trapper to utilize this as an access road, it would help us. The current practice of slash burning should be totally ended. When asked why they do it, we are told vaguely something about killing bugs. It baffles me why this is allowed at all what with the ozone crisis. Herbicides should only be applied in hack and squirt".

"Logging, clearcuts are okay in some areas but selective harvesting can take place in some areas but does not because our system is geared to harvest the forests for quick economic gain. Little regard is given the wildlife habitat. Our system of forestry has to be completely restructured meaning more value-added products, thus dramatically reducing the rate of harvest. In this way renewable forests and furbearers can be maintained. Less harvest-less silviculture-less herbicide-LESS IMPACT. Lets face it at the current rate of harvest can population that depend on old growth survive"?

"Logging/harvesting: clearcutting and planting in our deep snow area.
Silviculture practices such as thinning and pruning: good where required
Forest herbicides: back pump for alder, leave willow for moose
Mining: no problem
Road building: no problem
B.C. Hydro lines: no problem
Flooding: no problem
More people living in the area: no problem
Forest fires: been lucky so far
Clear cutting in narrow strips so that all skidding can be done to the main road and loaded there. Also to be laid out to eliminate blowdown as much as possible. In deep snow areas select logging only causes blowdown as the young trees cannot survive as the wind or the sun cannot take the snow off. The snow then breaks them down".

"I would like to see clear cutting curtailed and if needed much smaller areas clear cut. Clearcutting should be strip cuts and cut with the prevailing winds so as to eliminate as much blow down as possible. I would like to see some form of controlled forest fires. This would create better habitat for most species".

"This question is being answered with my opinion. What I would like to see, first off, the clear cut logging has to stop, or at least make smaller blocks. Selective logging (going in the area every year to take out the bigger trees and leaving everything else alone). Horselogging is an excellent way because in a couple of years you couldn't tell that they were there. The damage is hardly nothing. I don't believe in herbicides in any way, shape, or form. It kills many small animals needlessly, plus they don't know the long term effects. Road building, B.C. Hydro lines and mining are not too bad, depends on the volume and scale it is being done. Flooding Williston Lake doesn't do any animals any good, plus the lake is dangerous as hell. Small forest fires are good for all animals, big and small. Selective logging is the way to go. Only take the mature timber or the sick (bug kill). In this way no animals have to suffer any effects for logging. Plus we have timber always".

"Would like to see smaller clearcuts and possibly some type of selection cut. One must keep in mind spruce bark beetle infestations and windfirm boundaries and this is very difficult in my area. Roads no longer in use for the foreseeable future should be put to sleep, not just dug out. Wildlife trees are important and should be left behind providing safety of loggers and silvicultural workers is not endangered".

"Logging/harvesting: less logging, different logging (no clearcuts) small strips and big areas not logged. better logging cleaning up, piling, better use of what they take any areas of bare ground in cut blocks should be grass seeded and all roads and landings. Upland willow should be planted with spruce and pine seedlings.

Silviculture practices such as thinning and pruning: no thinning or pruning
Forest herbicides: no herbicides, cut area must come back to a natural forest with willow and poplar left to grow free".

"Logging removes habitat, the more that is done the greater the damage. Small skinny clear cuts if clear cutting must be done. Selective logging would be better. Absolutely no poisons should be used. You would be killing something's food and it all overlaps everything is hurt. Manual brushing is fine with is but with no herbicides".

"Smaller clearcuts, landscape logging when near rods i.e. across from Whiskers Point Provincial Park. Selective logging in areas near streams, rivers, and lakes (small equipment or horses)".

"Logging/harvesting: areas are overharvested.
Silviculture practices such as thinning and pruning: too extensive, nothing left but planted tree.
Forest herbicides: should be outlawed".

"Herbicides, pesticides and other poisons should not be used at **all.** Logging should be selective. Forests should be allowed to follow their natural cycle in regrowth. Flooding areas the size of Williston lake is a crime and should be stopped. People are fine just some of their antics need to be curbed".

"smaller clearcuts, selective logging, and no herbicides".

"snags should not be cut, too many clearcuts, too much debris left, you should clean up your debris".

"smaller clear cuts, strip logging, selective logging. As much debris as possible should be left to imitate nature wind fall and downed timber to create good habitat for rodents and under the snow habitat for marten. If man would observe nature, imitate it and forget about improving it. Nature has much longer training at this. Man is a slow learner because he does not accept the fact that mother nature knows best".

"we want logging and road building stopped completely".

Question 18 was optional and was asked for the purpose of determining how trappers would conduct this type of a survey and what questions they would ask. As with question #17, a few representative replies are included.

"The big laugh is this so called "integrated resource use" for instance. This season I have just been notified that a local company will be taking out 4 blocks of timber all in about 3 continuous square miles in what has been for many years my best marten area. There is the usual "if you have any concern or comments please feel free, etc., etc., etc. But the cold hard concerns fact is this company will be cutting this timber whether I like it or not. If *I* had the power to say "no" I order that you do not take out block number 3 till next year and my order was adhered to then to me that would be recognition of right as a fellow resource harvester. There is not, up to this date any such thing as "integrated resource management".

"This is a question that I find very difficult to answer. For example, on your questionnaire concerning habitat types. On my trapline I see lynx moving into 20 year old second growth (marten also). I see no category for that. This type of habitat is great for wildlife but the forestry solution to this is bulldoze and start over. (Not good for habitat) I can see that I am getting away from your question. It may be impossible for you, but if you want to find answers to these questions it might be advisable to go and see trappers. Talk to them, one on one. I'm sure you are restricted by finances as all of us are but a project like this may give you answers. All trappers have their own way of doing things but the profession is basically done the same. We trap animals for a living or a portion of a living. Weather conditions are uncontrollable bur fur damage and rates of harvest most often can be controlled".

"We check a trapline every day and run out 4 different lines or so amounting to around 30-35 miles. Our area is not skidoo country so we have to use snowshoes and packboard. Regarding the time it takes to trap a certain animal makes a trapper smile. We have this question asked by the game branch. They must think we set a trap and then watch it toile an animal gets caught. I don't think they understand the way a trapline is worked. I hope the way I answered this questionnaire is okay and is helpful. I believe from my experience as a trapper and mink ranger that for every animal that is taken in a trap there are at least 20 that die of starvation, annually. There were some years I couldn't take a proper harvest. This may sound odd, but the animals actually died down some due to litter loss because the nursing female had to work too hard to find feed she needed for her own body and produce the milk for her kits. Cannibalizing usually follows this condition. So the young that survive to the following winter may be cannibalized before it gets to be a year old".

"Don't know how. With regards to the beaver population in our area. We trap the Parsnip River and adjacent waters due to early freeze up we have difficulties in trying to manage this population. I made a suggestion to the Fish and Wildlife branch that all waters which are considered water sheds the season for beaver trapping should open October 1 not the 15th as it stands now".

"The only way I can see to answer some of the trapping questionnaires on trapping certain species is for you to come with me when I cut trail early in the season and to come back and trap the animal species when the seasons open. The distance, the trails are, the amount of traps and the weather. Many trips up mountains and down trails that take days and some time weeks to make are involved in trapping. Sometimes the weather doesn't allow you to trap when its best for you so at times like these you may have a hundred traps out on trails that aren't catching anything, but you still have to check your traps, this some times makes your time spent on trails (you worked and had to make and clear) useless but nobody can predict the weather. (Example) some times 20 traps will catch just as much as 100 traps, it depends on when the animal's move from cover and hunt for food. I'm not saying 20 traps is all you need but it doesn't matter how many traps you have, sometimes animals just aren't moving around. This happens throughout the season. This brings me back to why I would like to set my own season on some species (marten). Up in the high mountains snow comes early, marten prime fast, by the time the season opens, in some places there's too much snow already and it makes it too hard and expensive to trap there. If somebody really wants to know the right answer to questions the only way is to spend a season with a trapper".

"In answer to the question above I would I would send out a form to interested trappers only. The form would be for field use, ask for input then put into practice. You may say, forms again, but I would benefit as well as you and the rest of the trappers. To do the job in the field I would metal tag my sets and then record every visit, what was in it, sex, date, weight, time of day, weather, etc.

"Accurate records are invaluable. I also cut open the stomachs to see what their primary source of food is, location of trap, i.e. mature timber, alpine, river bottom, what ecological zone it is located in, aspect, slope and colour of fur. I have caught darker marten in mature forests than in old burn areas. Also record any peculiarities i.e. porcupine quills, broken teeth, etc.".

"How many hours it takes to trap and prepare an animal is how many working hours in a season and how many animals. Mostly is how plentiful the fur is and how fast and easy you can travel. I would not use Biogeoclimatic zones as you get wrong information on them use elevations, 2000-3000-4000,etc".

"You could ask how much time per mile do you spend, how much time do you spend handling fur, skinning, etc. What is having the most adverse affect on your business and how would you change that adversity (i.e. logging, mining, etc.)".

"Work with the trappers. I believe trappers should be subsidized by some kind of a formula when his area is partially used or exposed by other industry. Trappers pay up front for the privilege of trapping a line but are not considered financially when other resources are collected".

"For me the best way is person to person, I find I can get things across better by talking than writing answers. I think you have the right idea, keep up the good work, hope to meet you some day".

"There's some answer, some animals eating each other, I know of and some die off because some time hard winter but now a days even all game hard to get. A few years back there was more wolf than any other animal but it seems to move a long some where and moose is scarce. Because of road building all sort of disrupted and one more thing to say is I do have any mining in my area. Some winters I don't trap because of fur prices, most often cold weather spoils things. When I do trap I check them one week apart. I can not answer all, I do not have much to say, that's all I got for comment".

"Trapping was always our way of living in the past, present, and in the future, hopefully".

"To answer this questionnaire fully is impossible with yes or no answers it would take a book to cover everything. On of the worst things is slash burning, it destroys more birds and animals than anything else".

"There is too much coyote in some places. They are eating our catch - too much coyote".

"I am by now very weary of studies. The only one who benefits from a study is the one who gets paid to do it. The wildlife, the land, and the trapper, never gets any benefit. After each study, more clearcuts, more dams, less habitat. Having been here from pre Lake Williston time all have seen so far is exploiting the land".

"We want to know about trap laws, trail loss, etc. in regards to logging in our area".

9.6 Personnel Contacted

All trappers in the Williston Lake watershed (82) were contacted by mail and 25 responses were received to the questionnaire. The names are not included since all questionnaires have been kept confidential.

Other people contacted/interviewed:

Chico Crossland (Pres. Mackenzie Trappers Assoc.), McLeod Lake, B.C.
Robert Quadvilieg, Trapper, Mackenzie, B.C.
Murray McCullogh, Trapper, Mackenzie, B.C.
Jim Tuck, Retired trapper and Ministry of Forests, Mackenzie, B.C.
Andy Pakrastins, MOF, Mackenzie, B.C.
Merva Lyons, MOF, Mackenzie, B.C.
Harry Chingee, McLeod Lake Indian Band Chief, McLeod Lake, B.C.
Dave Lehan, Fletcher Challenge, Mackenzie, B.C.
Richard Krieger, Fletcher Challenge, Mackenzie, B.C.
Knut Atkinson, MOELP, Nanaimo,B.C.
Karen Morrison, MOELP, Nanaimo,B.C.
Bill Arthur, MOELP, Prince George, B.C.
Glen Watts, MOELP, Prince George, B.C.
Vivian Banci, MOELP, Victoria, B.C.
Eric Lofroth, MOELP, Smithers, B.C.
Steve Wasylik, MOELP, Mackenzie, B.C.
Dave Hatler,Smithers, B.C.